RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 38 MAY 1942 No. 5

The Management of Patients Receiving Radiation Therapy for Cancer[1]

LOWELL S. GOIN, M.D.

Los Angeles, Calif.

"PHYSICIANS," said Lord Francis Bacon, "are some of them so pleasing, and so conformable to the Humour of the Patient as they press not the true cure of the Disease; And some other are so Regular in proceeding according to Art, for the Disease, as they respect not sufficiently the Condition of the Patient." Among the former are those practitioners with the true bedside manner, while among the latter will be numbered far too many radiation therapists.

Radiation therapy is an art. It is one of the newer arts, founded upon one of the newer branches of science—radiation physics—and enormously indebted to those men and women upon whose researches has been erected so imposing an edifice. So impressive is the science, so erudite its background, so learned its exposition, that it is little wonder that those who practise the art based upon it are so dazzled by its glory that they fail to perceive some of its clinical applications.

Briefly stated, the thesis of this essay is this: Fascinated and impressed by such purely physical factors as wavelength, secondary and scattered radiation, surface doses, depth doses, exit doses, isodose curves, etc., radiation therapists, absorbed in treating a tumor, not infrequently forget to treat the patient. And yet, it is our prime purpose, as physicians, to treat a sick person, not a disease; to use every means at our command to cure or at least ameliorate disease, and to prolong life or to attempt to render it more bearable.

If we are to pursue the application of this thesis; if we are to recognize the patient as something more than a physical mechanism, then we must attempt to deal with him as a personality requiring not merely repairs, but understanding, sympathy, and affection. In short, we must recognize him as a sick human being, not merely as the bearer of an interesting tumor, and must proceed with his treatment on that basis.

Thus we come at once to the problem of what we shall tell a patient who has a malignant tumor. Shall we evade the issue and say that there is a slightly suspicious condition and that a few x-ray treatments are advisable? All too often, this is the verdict that the patient has received. Those who hold with such statements should reflect that there is neither happiness nor suffering that ever quite measures up to the anticipation thereof; that nothing in this world is quite as terrible or quite as wonderful as anticipation would have it. If a patient with a malignant tumor knows the truth, there follow

[1] Read before the Radiological Society of North America, at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

several desirable results: He is saved the sharp cutting pangs of fear that stab those who only wonder if their disease is cancer (knowing full well that radiation is employed in the treatment of malignant growths) and he is encouraged to summon all of his strength and courage to fight for his life, becoming thus more willing to submit to the arduous and disagreeable days of treatment that lie ahead of him. The fact, so familiar to all of you, that radiation therapy is no child's play is not so well known to the patient (and frequently not to the referring physician) and his shock on learning the truth will be materially lessened by the realization that he is fighting for his life.

But, the thoughtful patient may say, can you do nothing to make my ordeal less painful? Can you not lessen the misery that I must endure? Here begins the art of radiation therapy as distinguished from the science; here begins the function of the physician as distinguished from that of the physicist. Time is of the essence, say the lawyers, and we have long been drilled in the thesis that in the treatment of cancer we have no time to lose. True, we have not; but, if we are to consider the patient, and if we are to evaluate our end-result in the terms of his survival or at least in terms of his comfort and happiness during his survival, then perhaps it may turn out that a little time spent in preparing him for therapy is not lost and is in the long run a distinct gain.

Too many patients presenting themselves for treatment are in a physical state varying from rather poor to positively cachectic. Their ability to withstand an arduous course of therapy, and to recover not only from the disease but from the treatment, is governed to no little degree by their condition when first seen. Many persons with a malignant neoplasm are suffering not only from the disease but from misguided efforts directed toward its cure, as, for example, vegetarian diets, taken under the misapprehension that meat eating has something to do with the existence of cancer, that fruit juices are a curative agent, etc. Others, because of physiological disturbances secondary to the disease, are in deficiency states varying from mild to quite severe. These conditions demand attention before the actual therapy is begun if one is to hope for the most beneficial results. Appropriate vitamin therapy, high caloric diets, attention to anemic states, measures designed to improve the appetite and insure adequate sleep are as important as—or even more important than—the prompt beginning of therapy.

The mental state of these patients is frequently none too good, and one must be psychologist enough to attempt to overcome the profound melancholia and depression so frequently encountered. This is not to be accomplished by a Pollyanna attitude, nor by the Pangloss doctrine that "all is for the best in this best of all possible worlds," but in a calm factual analysis of the situation at hand. A patient with a Stage II cancer of the cervix, for example, should be talked to frankly. No attempt should be made to gloss over the situation, but it should be explained to her that, although the condition is grave, it is not hopeless; that thirty or more out of one hundred survive, and that, far from being beaten, she will have, with her hearty cooperation, a fair chance of survival. In general this sort of talk will result in a marked improvement in the patient's mental condition and a determination on her part to win in the ensuing struggle.

Having assured ourselves that the patient is in the best possible condition, we may commence the active treatment of the disease itself. Almost at once, in many instances, we will find the patient's progress reversed, and our efforts undone by our very efforts. We must, therefore, turn our thoughts to supportive treatment, by means of which we may hope to conclude the course of therapy without having inflicted too much injury to the bearer of the disease. Radiation sickness is a common, distressing, and not infrequently grave complication of treatment. Parenteral administration of liver extract (a rich

source of the vitamin B complex) will be of the greatest benefit, while B_1, as thiamin chloride, may be given intravenously in doses of from 30 to 50 mg. for the immediate control of the symptoms. The patient should also be encouraged to ingest considerable amounts of glucose, which may be obtained in easily assimilable form in corn syrup. In severe cases 10 per cent glucose in normal saline solution should be given intravenously by the drip method. The nausea accompanying radiation sickness naturally limits the caloric intake, and patients lose weight and strength rapidly unless measures are taken to counteract it. With the remedial agents mentioned must be coupled a high caloric diet ample to maintain weight or even to produce a gain. Not infrequently the patient is a middle-aged woman with a natural tendency toward obesity, whose vanity impels her to take a limited diet. This tendency must be checked, and in general these patients should not be permitted to lose weight.

Menopausal symptoms secondary to pelvic irradiation are often distressing. They are usually controlled without much difficulty by the use of one of the estrogens. Stilbestrol is one of the newer agents, and may be used in doses of from 0.1 to 0.3 mg. daily. It has some tendency to produce nausea.

Local manifestations of radiation effect may be most annoying and even quite painful. The dryness of the mouth and the loss of taste sensation so often accompanying mouth and neck irradiation may be quite well controlled with fairly large doses of thiamin chloride, 50 mg. or more daily, intravenously. The painful reactions within the mouth are very disagreeable. Nuporals (a trade name for A-buty oxy-cinchoninic acid di-ethylene diamide hydrochloride) has been very useful in controlling this symptom. It is employed in the form of troches which are allowed to dissolve in the mouth. The drug produces a mild surface anesthesia lasting two or three hours, and has for its only disadvantage the occasional production of nausea.

Among the most constant and most annoying of the complications of pelvic irradiation are cystitis, proctitis (with an accompanying diarrhea), and adhesive vaginitis. The prevention of the latter requires the most constant and unremitting care. Regular and systematic dilatation and packing with vaseline gauze are perhaps the best measures to employ. The use of stilbestrol in daily doses of 0.1 mg. has been suggested by experimental work, and deserves trial. The ingestion of large amounts of water and citrus fruit juices tends to control the cystitis, which fortunately is self-limited in any case. Small retention enemata of olive oil or of cornstarch are useful in combating proctitis, while the accompanying diarrhea is best controlled by paregoric and bismuth. A useful manner of employment is to prescribe equal parts of paregoric and milk of bismuth, a teaspoonful to be taken after each evacuation, thus making the intake self-regulating.

In conclusion:

1. The therapist must not lose sight of the sick person in his anxiety to treat the disease.

2. The general physical condition of the patient is of the greatest importance, and every effort must be made to improve the general health and to maintain the improvement.

3. The patient's psychic condition must not be neglected.

4. Certain means for combating common complications of radiation therapy are suggested.

5. The therapist is urged to be as good a clinician as his ability will permit and is assured that his therapeutic results will improve with the increased interest in the sick person committed to his care.

1930 Wilshire Blvd., Los Angeles, Calif.

Roentgen Therapy in Cancer of the Breast[1]

An Analysis of Experiences at the State of Wisconsin General Hospital during the Last Twelve Years

ERNST A. POHLE, M.D., Ph.D., and ROLAND R. BENSON, M.D.

Professor of Radiology and Junior Resident in Radiology, University of Wisconsin Medical School, Madison, Wis.

DURING THE LAST twenty years the treatment of carcinoma of the breast has developed from a purely surgical into a surgical-radiological problem. There can be no denying the fact that a sufficient number of carefully compiled statistics have been published demonstrating the value of postoperative irradiation in cases where metastases were present at the time of operation. We freely admit that the rôle of preoperative roentgen therapy in carcinoma of the breast has not yet been definitely established and likewise that it is too early to determine the effect of routine sterilization by roentgen rays in carcinoma of the breast in women in the preclimacteric age group.

In September 1940 Hidde *et al.* (1) published a statistical analysis of 318 patients with mammary carcinoma admitted to the State of Wisconsin General Hospital from 1924 to 1936, based on the status on July 1, 1938. They found that of 177 patients who received primary treatment at the University Hospital 30.4 per cent were still living, with observation periods ranging from three to fourteen years. These included Stages 1 to 3A, the latter referring to a patient with an ulcerated primary tumor plus metastasis in the axillary nodes; the majority (65.5 per cent) of cases were Stage 3. Since 1929 postoperative x-ray therapy has been a routine procedure and only 4 out of 125 patients seen from 1930 to 1935 were not irradiated. Although we must refer for further details to the original article, we wish to state that in conclusion the authors accept x-ray therapy as an important adjunct in the treatment of carcinoma of the breast. In advanced cases of recurrent or metastatic adenocarcinoma of the breast its palliative value is apparent while its curative value is poor. Since the study of Hidde and his associates was conducted chiefly from the surgical point of view, and because the patients treated during 1935 and 1937 have passed through a five- and three-year observation period, respectively, we considered it worth while to relate our experience, stressing particularly the radiological aspect.

TECHNIC OF TREATMENT

Preoperative Roentgen Therapy: Only a few cases were referred for preoperative irradiation and consequently no definite opinion as to its value can be offered. There are two possible methods of approach. One is to give an extensive series and then wait for two months to get the optimum amount of benefit from the treatment; the other is to give a shorter course of roentgen therapy and follow this either immediately or within a week to ten days by operation.

Postoperative Roentgen Therapy: Patients who do not show definite metastases at the time of operation receive only three or four series of six exposures each, administered at intervals of three, four, and six months over three fields: anterior chest, supraclavicular, and axillary regions. Moderate penetration (H.V.L. in Cu = 0.2 mm.) is used for the chest field and customary deep therapy radiation (H.V.L. in Cu = 1.05 mm.) for the other areas. The single dose per field is 200 r in air. Patients with metastases at the time of operation are treated with a four-field

[1] From the Department of Radiology and Physical Therapy, State of Wisconsin General Hospital. Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

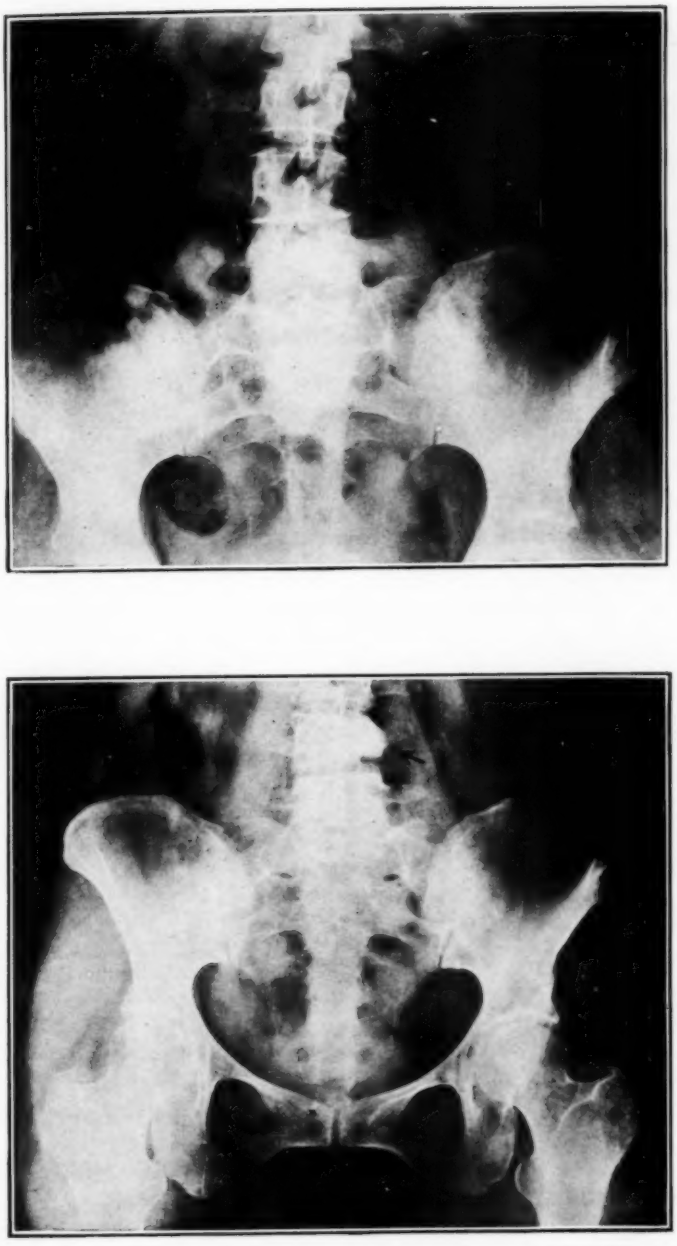
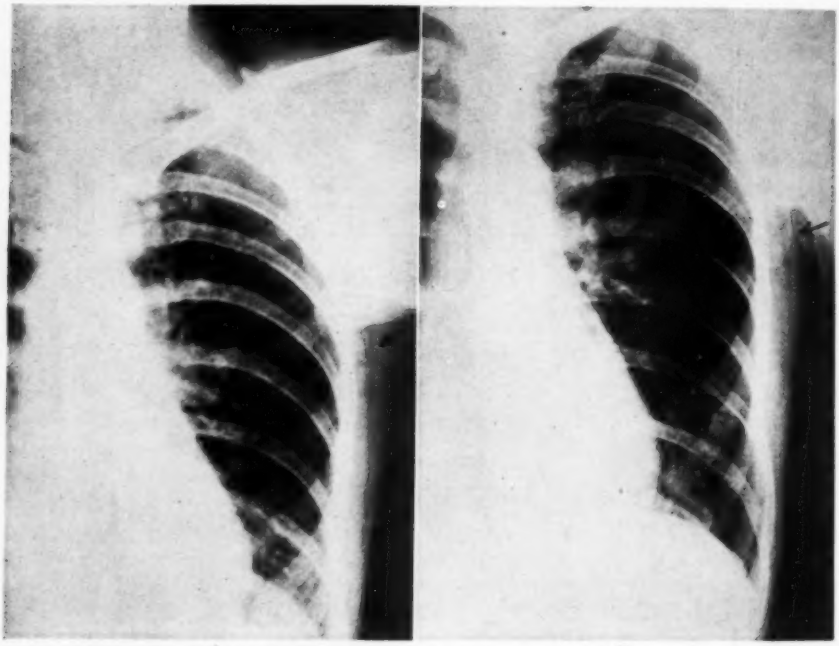


Fig. 1. Destructive lesion in lower left margin of fourth lumbar vertebra. Roentgen therapy: 6 × 150 r from April 22 to May 6, 1932; 3 × 150 r on May 20, 23, and 25, 1932; the same on June 14, 17, and 20, 1932. Almost complete relief from pain after third treatment. Definite calcification on July 5, 1932. The lower roentgenogram, taken on Jan. 20, 1933, shows complete healing. Lesion remained healed until death of patient two years later from generalized metastases. (From Pohle, E. A.: Clinical Roentgen Therapy, Lea & Febiger, Philadelphia, 1938.)

technic, anterior and posterior axillary fields being employed instead of a single one. The first course in this instance consists of eight exposures followed by series of six exposures at intervals of three, four, five, six, and six months. In this respect we follow the example of Holfelder, whose co-worker Weisswange (2) found that a reduction in the amount of treatment showed a drop of the five-year survival rate from 61.2 to 44 per cent.

Roentgen Therapy for Recurrences or Metastases: Metastases in the skin, bones, and one lung are treated locally. For skin nodules we use—depending on their thickness—a H.V.L. in Cu of from 0.2 mm. to 0.35 mm. (100 kv., inherent filter or 2.0 mm. Al; 130 kv., 0.25 mm. Cu + 1.0 mm. Al), applying 300 to 600 r in daily doses up to 3,000 to 4,000 r. For large areas with numerous scattered skin nodules this dose has to be decreased to 2,000 to 2,500 r.



A B

Fig. 2. Metastases from primary breast cancer. A. Roentgenogram taken in August 1939, before sterilization, showing destruction of tip of left scapula. B. Roentgenogram taken in April 1940, showing recalcification of defect. No local treatment given. (From Pohle, E. A.: Am. J. Surg. **54:** 491, November 1941.)

Roentgen Therapy in Advanced Inoperable Cases: Most of these patients come to the clinic with large ulcerated breast tumors and metastases in either axilla, the supraclavicular region, the skeleton, and occasionally the lungs. As a rule, no type of treatment offers much benefit, although it is necessary sometimes for psychological reasons to give a few exposures. In some instances simple mastectomy may be done, chiefly to remove the large amount of necrotic tissue.

Bone lesions often cause pain before they can be demonstrated roentgenologically. Consequently we have made it a practice to irradiate areas of constant and well localized pain in the skeleton even though the metastases could not be seen in the roentgenogram. We have had sufficient proof of the soundness of this procedure. The dose required to relieve pain and to bring about recalcification is a matter of debate. Some radiologists seem to favor fairly high doses, although we have definite

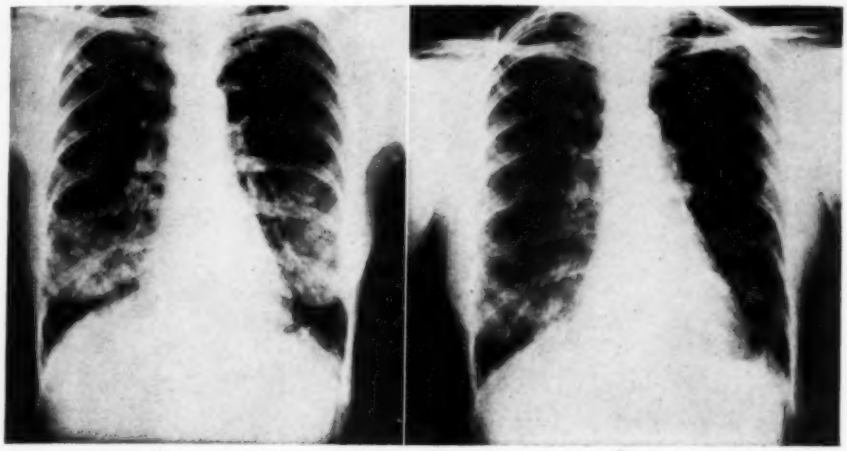
proof that two series of 4 to 6 × 200 r is frequently sufficient to bring about relief from pain and produce calcification. An illustrative case is shown in Figure 1.

Solitary lesions in one lung are treated locally and in some instances we have observed temporary regression. The customary deep therapy technic is used, the dose amounting to 8 to 12 × 200 r (in air) applied over an anterior and a posterior field.

all women of forty years or older operated upon for breast cancer, should be recommended as a prophylactic measure.

REACTIONS FOLLOWING ROENTGEN THERAPY

Acute Local Reactions: Reactions of the second degree are to be expected after the irradiation of skin metastases because of the large doses applied; erythema and pigmentation occur in those receiving prophylactic postoperative irradiation. We



A B

Fig. 3. Metastases from primary breast cancer. A. Roentgenogram of the chest taken in May 1937, showing bilateral metastases in the lung bases. B. Roentgenogram of the chest taken in May 1939, after roentgen sterilization; no evidence of metastases in lung bases. No local treatment to either lung. (From Pohle, E. A.: Am. J. Surg. **54**: 492, November 1941.)

In recent years sterilization of the ovaries by roentgen rays has been used successfully in the treatment of distant metastases from primary carcinoma of the breast. The mechanism of the effect is not exactly known, although there seems to be little doubt that the withdrawal of the hormones is responsible to a large extent. This assumption becomes especially convincing if sterilization is brought about by roentgen rays and the secondary deposits are so far remote from the pelvic fields of irradiation that a direct effect on the metastatic lesions is hardly probable. Two illustrative cases are shown in Figures 2 and 3. It is our opinion that roentgen sterilization of all women, regardless of age, who have metastatic carcinoma from a primary carcinoma of the breast, and of

advise oiling[2] of the exposed areas twice daily beginning with the day of the first exposure and continued for at least four to six weeks after a series has been completed. Meticulous care of the skin has its rewards, as evidenced by a comparison of patients who follow instructions with those who do not comply.

Systemic Reactions: More than 50 per cent of all patients treated by us suffer from various degrees of nausea and vomiting. We have never been able to find any satisfactory explanation for their occurrence nor any definite relationship between the condition of the patient, the number of treatments given, and the severity of

[2] Plain olive oil or Nivea skin oil, manufactured by Duke Laboratories, Inc., Stamford, Conn., has proved very satisfactory.

the systemic reaction. Although a good many remedies have been suggested to alleviate these annoying symptoms, no specific treatment has been discovered. In our experience 2 grains of nembutal, given as a suppository about one hour before treatment, and bed rest have been most satisfactory. Food and liquids should be offered in small quantities at intervals of half an hour to an hour, since a complete meal will rarely be retained.

Late Reactions in the Skin: Most of the patients who receive postoperative x-ray therapy as outlined in a previous paragraph develop some atrophy of the skin and telangiectasis (Fig. 4). In only one instance there occurred a breakdown in the outer axillary region with slight ulceration. This particular patient, however, had a very tight scar with fixation of the skin to the underlying bone, and the breakdown was in all probability due to trauma. Certain persons reacted to treatment with the development of a considerable amount of fibrosis, so marked in some instances that it made necessary interruption of the course of treatment originally planned. We feel that this phenomenon is very similar to the tendency in some people to keloid formation following a surgical incision. This reaction cannot be predicted and we do not know of any therapeutic measure to remedy it except gentle massage and daily oiling of the involved areas.

Fibrosis of the Lungs: Fibrosis of the lungs has been observed only occasionally in our series. We attribute this to the use of less penetrating radiation for the anterior chest area and the avoidance of cross-firing over large portions of the lungs. It occurred mostly in patients who were treated with the 4-field technic. As no symptoms referable to the mild degree of fibrosis were experienced, treatment was not required. The differential diagnosis between fibrosis and early metastatic spread into the lung parenchyma is often difficult; observation over a period of one year or longer may be necessary to ascertain the true nature of the process; fibrosis due to irradiation usually clears up slowly and does not increase if treatment is discontinued.

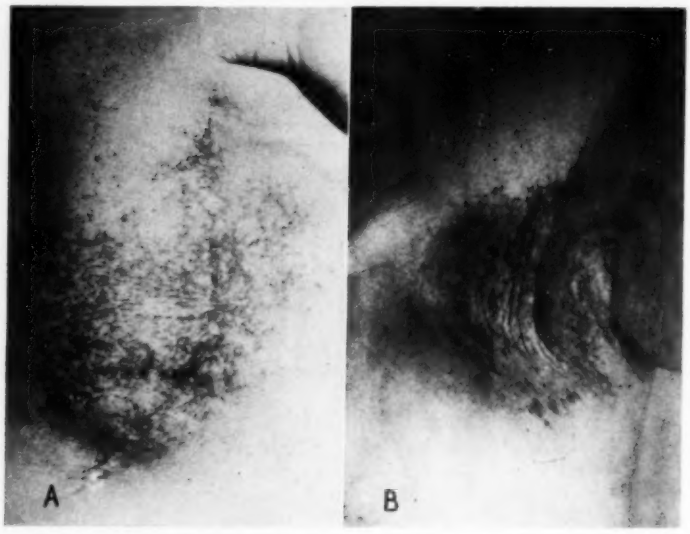


Fig. 4. Typical late skin reaction to roentgen therapy, five years after first series of treatments. A. Anterior chest area. B. Axilla.

Radiation Osteitis in Ribs: At varying times after the full course of therapy was

given, changes were detectable in the underlying ribs, consisting in pathological fracture or fractures, a variable amount of bone absorption at the edges of the fractures, and, generally, absence of reparative change over periods up to three years.[3] These findings were discovered incidentally on routine chest roentgenograms which are taken every three to six months in all of our breast cases (see Fig. 1-D, page 546). As a rule, the first roentgen evidence was fracture, manifested by a sharp change in alignment of the rib with or without a visible fracture line. In some an irregular transverse fissure or line of increased radiotranslucency first appeared. Usually after some months the zone of rarefaction became more pronounced, leading to well defined defects in the rib shadow measuring up to a centimeter in length. Varying degrees of displacement were encountered. A significant feature was the complete absence of symptoms referable to the fracture in all cases. In the first few cases the lesions were considered to be metastatic, and one patient received further roentgen therapy directed to the rib lesions. In the remainder the nature of the lesion was recognized, as we had become aware of the possibility from observing the previous cases. All of the lesions were in the anterior or anterolateral segments of the upper ribs, usually the third, fourth, and fifth. Although we have no histological proof, we believe that the lack of progressive destruction and the smoothing off and eburnation of the surfaces can be considered acceptable evidence for the correctness of our interpretation.

ANALYSIS OF CASES

Postoperative X-Ray Therapy: In 1935 there were referred to the Department of Radiology for postoperative treatment 42 patients with the diagnosis of carcinoma of the breast. Seventeen of these had no evidence of metastases at the time of operation, while the remaining 25 had involvement of the axillary lymph nodes; the respective figures for 1937 were 18 and 23.[4] The age incidence is shown in Table I and the microscopic classification in Table II. From the latter it appears that duct carcinoma is the most common type encountered in our series.

TABLE I: POSTOPERATIVE ROENTGEN THERAPY SERIES: AGE INCIDENCE

Years	1935*		1937	
30–40	6	2	2	2
41–50	2	11	4	10
51–60	5	5	9	6
61–70	2	6	3	4
71–80	2	1	..	1
TOTAL	17	25	18	23

* In this and the following tables the first column in each year refers to patients without metastases at operation, the second column to those with metastases at operation.

TABLE II: POSTOPERATIVE ROENTGEN THERAPY SERIES: HISTOLOGY

	Number			
Type	1935		1937	
Duct ca.	6	22	7	11
Adeno-	6	2	4	7
Scirrhous	3	1	2	2
Colloid	1	..	..	..
Unknown	1	..	5	3
TOTAL	17	25	18	23

Table III summarizes the end-results. In compiling these figures every patient not strictly accounted for by examination in our department or not traced on Jan. 1, 1941, has been considered as dead from cancer. There were 2 patients untraced in the 1935 group and 4 untraced in the 1937 group. Of the patients treated in 1935, without metastases at the time of

TABLE III: POSTOPERATIVE ROENTGEN THERAPY SERIES: END-RESULTS

	Living and Well			
Years	1935		1937	
5 or more	9	7	..	..
4 or more	..	1	..	..
3 or more	3	1	10	10
2 or more	1	6	..	2
1 or more	3	4	1	6
Less than 1 yr.	..	6	3	4
Not traced	1	..	4	1
TOTAL	17	25	18	23
	42		41	

[3] For a detailed discussion of this topic see the paper by Paul and Pohle on page 543 of this issue of RADIOLOGY.

[4] Because of the relatively small number of cases, no differentiation as to stages will be recorded. Most of them were of Group 3.

operation, 70.6 per cent were free from recurrence after three years, but of those with metastases only 36 per cent, a combined percentage of 50 per cent. The respective figures for 1937 are 55.6, 43.5, and 48.8 per cent. The pronounced drop in the three-year survival rate for patients without metastases in the two groups is hard to explain, especially in view of the fact that in 1937 practically all cases were treated with the 4-field technic. The combined rates—50 and 48.8 per cent—are, however, almost identical. The five-year figures are 53 per cent living and well for those with no metastases at operation; 28 per cent for those with metastases at operation, a combined rate of 38.1 per cent.

TABLE IV: METASTASES FROM BREAST CANCER: AGE INCIDENCE

Years	1935	1937
30–40	2	7
41–50	9	15
51–60	8	13
61–70	6	5
71–80	3	2
TOTAL	28	42

TABLE V: METASTASES FROM BREAST CANCER: DISTRIBUTION OF LESIONS

Location	1935	1937
Skin	4	3
Skeleton	6	12
Lungs	3	4
Lymph nodes	3	7
Multiple	12	16
TOTAL	28	42

TABLE VI: METASTASES FROM BREAST CANCER: OBSERVATION PERIODS

Time	1935	1937
3 years or +	1	7
2 years or +	..	2
1 year or +	2	5
6 mo. or +	6	12
3 mo. or +	9	4
Under 3 mo.	10	12
TOTAL	28	42

Metastases: In 1935 28 and in 1937 42 patients with metastases secondary to carcinoma of the breast were seen and treated. The age incidence is shown in Table IV, the distribution of the lesions in Table V, and the observation periods in Table VI. In evaluating the results we recorded primarily the degree of symptomatic relief experienced by the patient rather than the duration of life after therapy was begun. Most of the patients came with advanced lesions, as shown by the high percentage with multiple foci (see Table V). On that basis Table VII was computed. It appears that worth-while relief was obtained in 64.3 per cent (1935) and 69.2 per cent (1937), respectively. We must therefore consider roentgen therapy to be one of the best palliative measures in the treatment of metastases from primary carcinoma of the breast. Skin lesions often disappear entirely, enlarged nodes are reduced in size, the pain in bone foci is relieved and destroyed areas often recalcify, solitary nodules in the lung may recede, and the effusion accompanying pleural involvement may be resorbed. Two illustrative cases are reported below.

TABLE VII: RESULTS OF ROENTGEN THERAPY IN METASTASES FROM BREAST CANCER

Degree of palliation	1935	1937
Good	8	21
Fair	10	8
Poor	10	13
TOTAL	28	42

CASE X2745: A 42-year-old female had the right breast removed in November 1930. In December 1932, a lump 4 cm. in diameter developed near the right lateral border of the sternum at the junction of the 5th rib. Two series of treatments were given with good response; the nodule disappeared. In September 1933, a local recurrence was treated successfully. In December 1933, a nodule developed in the left nipple, was irradiated, and disappeared. In February 1934, there was a recurrence on the right side, which responded well to x-ray therapy. In April 1934, there was no evidence of carcinoma. The patient did not return until December 1935, at which time she showed generalized skeletal metastases; good palliation followed irradiation. The patient was last seen in June 1936.

CASE X4878: A 52-year-old female had a radical removal of the right breast in March 1931. During the following years recurrent skin metastases were removed surgically on three different occasions, the last in July 1935. In September 1936, an effusion developed in the right lower chest, apparently due to

pleural metastasis. Thoracentesis plus roentgen therapy at intervals of three to four months achieved very good palliation and the patient was kept comfortable until March 1938.

FOLLOW-UP SYSTEM

Most important is a thorough examination of all patients at regular intervals following operation. Since our plan of postoperative roentgen therapy calls for a number of series of treatments to be given during the first two years after the operation, most patients do return when asked. After that it is a matter of education and encouragement to assure a follow-up examination at least at six-month intervals, which should include a roentgenogram of the chest. Every patient receives a return appointment card indicating the date and hour of the next visit. There is also a note at the bottom requesting notification of the department should the appointment be broken. By co-operation with the family physician we have been able to maintain a nearly 90 per cent follow-up.

SUMMARY

1. The technic of postoperative roentgen therapy and of roentgen treatment of metastatic lesions secondary to carcinoma of the breast as practised in the Department of Radiology at the State of Wisconsin General Hospital is outlined.

2. Acute and late reactions following treatment are discussed.

3. An analysis of 42 patients treated postoperatively in 1935 and of 28 patients treated for metastases is presented. Identical figures are given for 41 and 42 patients, respectively, treated in 1937. The five-year survival rate for all patients treated in 1935 was 38.1 per cent and the three-year survival of all patients treated in 1937 was 48.8 per cent. These figures are based on the assumption that all patients not examined by us or untraced died from cancer. Satisfactory palliation in those with metastatic lesions was obtained in approximately 60–70 per cent.

4. Roentgen therapy is considered a valuable adjunct in the treatment of operable carcinoma and roentgen rays represent the best palliative therapeutic agent in the treatment of metastases secondary to carcinoma of the breast.

University of Wisconsin Medical School
Madison, Wis.

REFERENCES

1. HIDDE, F. G., MALEC, J. P., AND GALE, J. W.: Carcinoma of the Breast. Am. J. Surg. **49**, 427–433, September 1940.

2. WEISSWANGE, W. M. H.: Die Aufgaben der Strahlentherapie in der Behandlung des Mammakarzinoms. Ergebn. d. med. Strahlenforsch. **7**: 513–572, 1936.

The Place of Irradiation in the Treatment of Cancer of the Breast[1]

FREDERICK W. O'BRIEN, M.D.

Boston, Mass.

INOPERABLE CANCER OF THE BREAST

IRRADIATION is freely conceded a place in the treatment of inoperable cancer of the breast. The frankly inoperable tumors with or without secondary manifestations, although hopeless from a curative standpoint, receive enough palliative benefit to warrant accepting such patients for irradiation when not *in extremis*.

Ulcerating breasts will frequently heal and axillary and supraclavicular nodes regress but, more often than not, while this proceeds secondary deposits appear in the skeleton or other organs. Care should be exercised, as Quick (1) has emphasized, that these patients have proper medical supervision. A discriminating use of antianemic and supportive remedies, together with sedatives and relatively small doses of radiation, help some to live in comparative comfort for a few months to years.

LOCAL RECURRENCES

Local recurrences in the skin or scar, when the nodules are discrete and few in number, may be excised surgically or treated by surface or interstitial applications of radium or by intensive roentgen radiation with a well localized field. Radium must be used with caution if applied to a field previously subjected to intensive irradiation from an external source. If the nodules are multiple and contiguous, surgical removal is not usually advisable because of the loss of skin entailed thereby. In such cases high-voltage x-rays or radium, when available in sufficient quantity, are better employed.

The appearance of secondary nodules in the scar or skin of the breast area usually means that extirpation of the mammary gland has not been wide enough. Hicken (2) has shown by mammographic studies that the lactiferous ducts spread over the entire anterolateral wall of the chest. Breasts supposed to have been completely excised by "mastectomy procedures" were examined by him after injection of the ducts with a solution of methylene blue. He did not find a single instance in which the mammary tissue had been removed in its entirety. In 94 per cent of the cases the dye escaped in the subareolar zone, indicating that some of the breast tissue had been left attached to the reflected skin flaps.

In a study of 255 cases of breast cancer previously reported by me (3) recurrence in the skin or scar was found in 21 per cent. The appearance time of the local recurrence in this group seemed directly related to the completeness of the surgical excision and the extent of the disease at the time of operation rather than to the kind of tumor. This is not surprising when one is acquainted with the lack of uniformity in surgical procedures. Saltzstein (4) found that 60 per cent of surgeons do the original Halsted-Willy Meyer radical operation; 30 per cent frequently leave the minor muscle, while 8 or 10 per cent always do, and 15 per cent leave the pectoralis major in some cases, especially if the growth is below and outside the nipple or if the case is far advanced.

DISTANT METASTASES

Distant metastases, in contrast to local recurrences, involve other factors than completeness of operation and extent of the disease. Here the kind of tumor and its method of spread, whether by the lymphatics or venous system as recently demonstrated by Batson (5), seem of major importance. The estrogenic theory of

[1] Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

multiple foci of origin must also be considered when discussing what seems to be a metastasis but what in reality may be one of several primary foci.

Often enough what are presumed to be postoperative metastases were actually present at the time of surgical intervention. It is safe to assume that bone metastasis demonstrable by x-ray ten days after operation has been present for a much longer period. In more than 50 per cent of one operated series examined by me there was no record of preoperative diagnostic x-ray examination. Roentgen studies of the chest, spine, and pelvis, as White (6) counsels, should be made before operation without regard to the smallness of the primary tumor, lack of nodes, or suggestive symptoms. With this procedure, many cancers clinically localized will prove to be diffuse and inoperable.

Distant metastases may be controlled for long periods by appropriate gamma radiation or high-voltage x-rays. When bone metastasis is suspected, irradiation should be promptly directed to the site of the pain, irrespective of so-called negative diagnostic films. The entire vertebral column may be riddled with tumor not demonstrable roentgenologically. Any orthopedic appliance used in the presence of collapse of the vertebral bodies or fracture of the long bones that will preclude irradiation, since new bone formation often enough follows, should be interdicted. Occasionally generalized skeletal metastases have disappeared completely following irradiation of the ovaries. Roentgen castration and its relation to cancer of the breast will be discussed later.

Pleural effusion sometimes resolves after relatively small doses of x-rays of medium voltage and the progress of lung metastasis may be halted by fibrosis deliberately produced by supervoltage radiation. Such therapy, to be sure, is merely palliative, but is comparable in a degree with therapeusis in certain other chronic but fatal maladies common to the field of internal medicine.

PRIMARY OPERABLE BREAST CANCER

The place of irradiation alone, or in conjunction with surgery, in the treatment of so-called primary operable breast cancer remains in the realm of polemics.

Irradiation as the sole therapeutic measure seems justifiable in cases otherwise operable but which are poor surgical risks, in borderline operable cases, and in especially organized clinics. Keynes (7), since 1922, has treated 390 selected cases of operable cancer of the breast with buried radium needles. He sometimes removes the breast by diathermy. His survival rate compares favorably with that reported in many surgical clinics. To employ his method, one must know regional anatomy and be surgically trained.

I am not aware that anyone has systematically treated primary operable breast cancer with x-rays alone, except when surgical intervention has for some reason been contraindicated, and such cases do not run into sufficient numbers for statistical comparison with the work of Keynes.

Other things being equal, with our present knowledge irradiation to the exclusion of surgery should not be employed, in my opinion, in that group of mammary cancers which with radical mastectomy give a five-year cure rate (alive without disease) of 70 per cent or better, as reported by Simmons, Taylor, and Welch (8) and their associates. This is a rigidly selected group, but that is as it should be.

By radical mastectomy is meant the classical operation wherein breast, both muscles, and axilla are extirpated. It is difficult to be patient with those who, like Fitzwilliams (9), plead for a local operation in early breast cancer. How can one be satisfied with local mastectomy when it is common knowledge that 30 per cent of cases classified clinically as early have already invaded the axillary nodes? Fitzwilliams' argument is specious. "An early case," he writes, "is one in which there is a fairly perceptible something in the breast, hardly a lump and certainly not a tumor. It has not well marked textbook char-

acteristics of malignancy. These tumors have one invariable characteristic which is all important for diagnosis; they show a shadow on transillumination with strong light. If such a shadow is seen, the tumors, after excision, will nine times out of ten be found to be carcinomatous. Transillumination is the only method by which they can be diagnosed." This latter statement is in direct contradiction to that made by Cutler (10), who states that a differentiation of carcinoma in solid tumors cannot be made by transillumination. Fitzwilliams, having laid down the limits of safety for others, owns that he has not always kept to them. That is a very practical aspect of the matter, for there are surgeons who appear to look for reasons to avoid radical mastectomy, either because of their inability to perform it or because of the time-consuming, meticulous care it demands. "Those brought up in the atmosphere of the radical operation," says Fitzwilliams, "with no experience of anything less extensive, must remember that they are respecting dogma and not speaking from formed judgement," which sounds dogmatic enough.

The extent of the disease has come to be recognized as the most important single factor in influencing cure. It would seem the part of wisdom to drop the term operable breast cancer and use the term curable cancer. The surgeon who thinks in terms of curable breast cancer will be less likely to intervene in a case technically operable but in which longevity will immediately be shortened by surgery. Once the disease has extended to the axilla, the five-year surgical cure rate drops to about 30 per cent.

Less emphasis is placed on the grading of malignant neoplasms than formerly, for it is known that, regardless of the grade, if the tumor is localized and removed in its entirety the cure rate is not affected. The grade of malignancy, however, has a prognostic value. Tumors of high malignancy are more common in the younger age group and are more apt to have already metastasized. These are the cases which for the most part prevent a perfect surgical cure rate.

This suggests the advisability of *preoperative roentgen or radium therapy*, not with the idea of supplanting surgery but to complement it, nor with the idea that an inoperable cancer will be made operable in the sense of curability by irradiation but solely in an endeavor to immobilize tumors of high malignancy in an attempt to improve the cure rate of this group. Much of the criticism of preoperative irradiation has been justified. With our present knowledge it can be done without prejudice to rather prompt surgical intervention.

The work of Adair (11) and his associates is quoted frequently in disparagement of preoperative irradiation. Following literally the method employed by Adair, one would have to expect the untoward results described by him, but it should be recalled that he purposely used large doses of intensive radiation to obtain data on the cancerocidal effects of x-rays on the tumor in the breast and axillary nodes. I do not believe that radiation in amounts to sterilize the tumor is eitherd esirable or necessary. Its chief preoperative application should be to modify the undifferentiated young neoplastic cells, as Coutard (12) has recognized. This can be done with relatively small amounts of radiation given within a reasonable time and without the production of fibrosis. Surgical intervention can be then instituted, Coutard says, before the possible appearance of new young cells, that is to say, before the twentieth day and, in any case, before the slight skin reaction of the twenty-fifth day. If the irradiation provokes a great reduction in the volume of the tumor, appreciable about the fifteenth day, one would have proof that the cancer was very radiosensitive, very rich in young cells. Had surgery been practised at once it might have been followed by recurrence at a distance or by metastases.

Melnick and Bachem (13), working with transplantable rat tumors and massive doses of x-rays, and Melnick (14), using

radon implants, found the familiar and undesirable sequelae of intensive radiation, namely, necrosis of tumor, hyperemia, cellular infiltration, granulation tissue proliferation, fibrosis, and blood vessel changes, whereas after fractional protracted methods of irradiation only the most radiosensitive cells were found to be destroyed without the production of fibrosis and vascular changes.

In view of these experimental findings, Halley and Melnick (15) now prescribe preoperative irradiation extending over four to five weeks, followed by amputation within two to four weeks. A shorter preoperative course fails to obtain optimum tumor damage. Surgery done within two to three weeks after irradiation offers the advantage of a tissue in which viable tumor cells have been decreased to a numerical minimum with slight damage to the tumor bed. Delay of surgical interference beyond four weeks, say these investigators, faces regrowth of the tumor.

Optimum spacing of the radiation dose may well be the crux of the entire problem, as indicated in the work of Spear and Glücksmann (16). Exposing tissue cultures to gamma radiation, they found that with very small doses there was no recognizable change in the behavior of the irradiated cells, that there was a threshold dose which prevented some cells from dividing but that normal mitosis occurred later on and no degenerate cells were produced. A maximum dose delivered at one exposure produced a breakdown of cells with an increase in the number of differentiating cells, whereas with the same dose delivered in two exposures at an optimum spacing (ten days in the experiments) mitosis was reduced almost to zero with a large amount of degeneration.

Among the other objections raised against preoperative irradiation one hears that delay in operating creates a mental and physical hazard for the patient and, furthermore, that there is no evidence to prove that preoperative irradiation is of any benefit. This last objection will remain imposing and difficult to answer while surgeons hold out steadfastly against trial of the method. For patients seen privately or in the tumor clinic no mental hazard need exist if they are assured that the irradiation is in preparation for surgical excision later. The physical hazard already exists. The tumor either has or has not extended to the axilla and beyond at the time of the first examination. It is difficult to reason that immediate irradiation will stimulate the spread of the disease rather than immobilize what is already there. There is no scientific evidence that radiation stimulates tumor growth, but abundant animal and human evidence that it is halted thereby.

Those cases with axillary nodes, classified as CII, in my opinion constitute another definite field for preoperative radiation, in the first place to differentiate inflammatory from carcinomatous nodes. If the nodes disappear, one may reasonably give a better prognosis. If they persist, as they do when carcinomatous, preliminary irradiation, as Quick (17) observes, may immobilize tumor cells which otherwise would be disseminated by operative trauma.

Routine postoperative irradiation has been abandoned in some clinics because of apparently paradoxical results and carried on in others in the belief that the question is still *sub judice*. I feel strongly that, if routine postoperative irradiation is to be given in its commonly accepted sense of prophylaxis, then many more fields of irradiation should be utilized than is the prevailing custom, as has been suggested by Lenz (18) and others. It is not sufficient to treat the affected chest wall, axilla, and supraclavicular chain of lymphatics; the mediastinum and parasternal nodes and lymphatics of the opposite breast must be treated as well, over a protracted period.

Postoperative irradiation, however, does not seem necessary or indicated in those patients in whom the disease has been shown by diagnostic roentgen, operative, and pathological examinations, to be localized in the breast, that is, those cases classified as CI PI, with the exception of grade

III tumors. Graves (19) found the percentage significantly better in early cases of high malignancy with axillary nodes not involved, a 70 per cent five-year cure for those having had irradiation as against 35 per cent in those not receiving postoperative x-ray therapy.

Postoperative irradiation has been a useful therapeutic measure, in my experience, in those patients in whom the disease appeared clinically to be localized to the breast but on pathological examination was found to have extended to the axillary nodes. In one series examined by me 39 per cent so classified, CI PII, lived over five years without demonstrable disease.

By far the larger group referred to my department at the Boston City Hospital for postoperative irradiation is made up of patients classified as CII PII, in whom operation was frankly inadequate or its completeness in doubt. Irradiation in this group is usually only palliative, given with the idea of growth restraint, in the hope that if the remaining cancer cells were implanted elsewhere they may be less viable. Sometimes the surgeon appears critical of irradiation because it has failed to compensate in some miraculous way for lack of surgical judgment. Wolfer (20) pertinently says: "Too frequently the surgeon advises operative therapy, not because the form of treatment is best suited to the case in question but because it represents his one and formidable type of treatment."

Of 50 consecutive hospital cases studied by me and classified as CII PII, 29 treated by surgery alone lived, on the average, nine months, while 20 who received postoperative irradiation lived, on the average, over three years. Not a single patient in the non-irradiated group lived five years, while in the irradiated group five lived beyond this period.

An excellent monograph (21) published in 1940 on the treatment of cancer of the breast, in censure of postoperative irradiation, quoted statistics from a paper that appeared in 1935 based on cases operated upon and irradiated from 1910 to 1929, a period when radiation therapy had hardly reached adolescence. Many clinics during this time were treating patients with apparatus of diagnostic potential only. Practically our entire concept of the physics of radiation and its clinical application have been crystallized in the past ten years. Statistical data founded on methods abandoned for more than a decade should be presented merely for what they are.

It should be plain that end-results bear a direct relation to the criteria of operability, the extent of the disease, the degree of malignancy, pathological interpretation, the kind of operation done, the skill of the operator, and any supplemental measure such as radiation. It is one thing to compare surgical end-results in cases free of axillary nodes with similar cases that have had radiation added, but something quite different to compare cases with axillary nodes plus something else. It is necessary to know how extensive the disease was at the time of surgery and the time, in relation to surgery, that radiation was applied.

In a recent paper, Harrington (22) gave the following criteria of operability:

"Any lesion of the breast was considered to be operable if it was freely movable from the thoracic wall regardless of ulceration. In some cases, even if there were cutaneous nodules proximal to the tumor, regardless of the presence or absence of palpable axillary lymph nodes, the lesion was considered operable. The same view of operability was held in most cases in which supraclavicular nodes were palpable but were confined to one side. In addition, patients were accepted for operation if they had a diffuse type of malignant growth, if malignant disease was associated with lactation and, in most cases, if malignant disease was associated with pregnancy. Those conditions were considered to be inoperable in which a large growth was fixed to the thoracic wall and there was very extensive metastasis to the regional lymph nodes or metastasis to other distant parts of the body. A few patients who had metastasis that involved distant portions of the body were accepted for operation because of exceptional circumstances."

The criteria for operability as stated by Haagensen (23) are as follows:

"Radical mastectomy should be done in all women with carcinoma of the breast whose general physical

condition permits major surgery, whatever their age, and even though the lesion be bilateral, except under the following conditions, which are indications that surgery will not cure:

"1. Development of the breast tumor during the course of pregnancy or lactation.

"2. The so-called inflammatory type of breast carcinoma (diffuse enlargement of the breast, redness, edema, and elevated temperature of the skin affected).

"3. Extensive edema of the skin over the breast (more than one-third of the skin affected).

"4. Satellite tumor nodules in or beneath the skin over the breast or adjacent chest wall.

"5. Intercostal or parasternal tumor nodules.

"6. Edema of the arm.

"7. The presence of any two or more of the following signs of locally advanced breast carcinoma (one does not suffice).

"(*a*) Ulceration of the skin.

"(*b*) Edema of the skin over the breast of limited extent (less than one-third of the skin affected).

"(*c*) Fixation of the tumor to the chest wall.

"(*d*) Fixation of the axillary lymph nodes to the skin or to the deeper structures of the axilla.

"(*e*) Axillary lymph nodes measuring 2.5 cm. or more in transverse diameter.

"8. Proved or clinically unquestionable supraclavicular metastases.

"9. Distant metastases to the contralateral axilla, lungs, bones, liver or elsewhere."

Neither is there uniformity in the bases for reporting statistical data. Five-year survivals (alive with disease) are quite different from five-year cures (alive without demonstrable disease). End-results based on a clinical classification of cancer of the breast, such as that of Steinthal, are quite misleading. In one series of Harrington's, analyzed by Pack and Livingstone (21), 29 per cent of the patients without palpable nodes grouped clinically as CI nevertheless had cancerous invasion of the axilla and 32 per cent with palpable nodes grouped clinically as CII had no metastatic cancer in the axilla. The adoption of a clinico-pathological classification such as that of Portmann (24) would seem essential groundwork for follow-up studies.

CLASSIFICATION OF MAMMARY CANCER (Portmann)

Group or Stage I

Tumor: Localized in the breast and movable
Skin: Not involved
Metastases: None in axillary nodes or elsewhere

Group or Stage II

Tumor: Localized in the breast and movable
Skin: Not involved or slightly edematous or ulcerated over tumor
Metastases: Few axillary nodes involved. No other metastases

Group or Stage III

Tumor: Diffusely infiltrating breast; fixation of tumor or breast to chest wall; edema of breast; secondary tumors
Skin: Edematous; brawny induration and inflammation; extensive ulceration; multiple secondary nodules
Metastases: Many axillary nodes involved or fixed. No clinical or roentgenological evidences of distant metastases

Group or Stage IV

Tumor: As of any other stage
Skin: As of any other stage
Metastases: Axillary and supraclavicular nodes involved. Clinical or roentgenological evidences of distant metastases

ROENTGEN CASTRATION IN BREAST CANCER

Experimental research has now entered to complicate the ultimate evaluation of the problems of breast cancer. It has lent increasing support to those who counsel castration by irradiation either preoperatively or postoperatively. Practically the place of this procedure in the treatment of cancer of the breast is more limited than theoretically one would surmise. Perhaps this is due in part to our failure to explore all its implications.

Castration for recurrent or inoperable cancer of the breast is not of recent origin, nor are the results obtained constant or altogether in agreement with what might be expected. Schinzinger (25) in 1889 theorized that cancer of the breast in the elderly female was not as rapidly progressive as in younger women and suggested bilateral oophorectomy to effect a functional sterility by production of a premature menopause. Beatson (26) in 1896 recommended the same surgical procedure but on the basis that the changes which take place in the mammary gland in the process of lactation as the result of ovarian activity are almost identical with those taking place in the cancerous breast. He had learned that it was the custom in certain countries to remove the ovaries of a

cow after calving to insure the giving of milk indefinitely, which fact permitted him to deduce that one organ might hold control over the secretion of another and separate organ.

Thomson (27) in 1902 collected 80 cases in which oophorectomy had been performed in the presence of inoperable carcinoma of the breast with brilliant results in a few cases but with only a transitory effect in the majority, extending to periods of three and one-half years in a limited number. About 64 per cent of the series showed no improvement. Thomson concluded that no particular age was a contraindication for operation, that metastasis in the viscera or bones was not influenced by oophorectomy, and that the best results were obtained in cancers of slow growth, where the local disease had been submitted to a complete operation and recurrence had taken place in the form of isolated nodules in the neighborhood of the scar.

In an analysis of 93 cases published by Lett (28) in 1905, he found 36.4 per cent materially benefited by the operation. He believed the most favorable age was forty-five to fifty, and the fact that a patient had passed the menopause was not a contraindication. Following the lead of Beatson, Thomson and Lett prescribed thyroid medication because of the contrary hormonal influences on the mammary gland of the thyroid and ovarian secretions.

Surgical castration was not without its critics. That mammary cancer so frequently arises in elderly women long after the climacteric was often voiced to oppose the view that castration was a means whereby the development of the disease could be prevented.

With the discovery of x-rays and radium and their application in therapy, irradiation of the ovaries as a substitute for castration by operation soon found favor, since no operative mortality resulted. Hopeless cases that never would have been submitted to a major surgical procedure were now subjected to irradiation with results not nearly so favorable as those reported following surgery.

Ahlbom (29), in a carefully reasoned paper based on 163 cases treated at the Radiumhemmet from 1922 to 1928, found no definite proof in support of the favorable effect of castration but was careful to state "the material included very few cases in which one has the greatest reason to expect a favorable response, namely, still menstruating women who do not give evidence of any spread of the cancer beyond the first lymphatic station."

Curiously enough, in recent years the majority of patients reported as having benefited by roentgen or radium castration are those with distant skeletal and visceral metastasis in whom surgical castration was considered contraindicated. Dresser (30) reported his experience with 59 patients with cancer of the breast with bone metastases who received ovarian radiation; 30 were under forty-five and 29 were of postmenopausal age. Of the group of 30 who had not reached the menopause 9, or 30 per cent, showed definite regression of the bone metastases as determined by frequent roentgen examination. No patient who had passed the menopause showed evidence of regression of the metastatic process.

The work of Lathrop and Loeb (31), who produced the first definite experimental evidence of the effect of sex hormones on the development of cancer in mice (failure of cancer of the breast to develop in female mice of a known high-cancer strain following castration while young or immature) was in major part responsible for the renewed interest in roentgen castration. Their work was corroborated by Cori (32). Lacassagne (33) reported the occurrence of mammary cancer in male mice which had been feminized by injections of estrogenic hormones, and Allen and his associates (34) confirmed this phenomenon, giving added proof that the estrogenic hormones could produce cancer in susceptible animals.

Since Frank (35) and his co-workers have shown that estrogenic activity may

still be present in some women after the menopause, Olch (36) suggests that this may be a factor in the development of mammary cancer in later life. By combining the figures of several writers, he found that 71.7 per cent of women pass through the menopause between forty and fifty, which he considers the normal range in this temperate climate. If one notes the age of the menopause in older women with mammary cancer, that is those noticing their tumors after the age of fifty, one is struck, he says, by the greatly increased percentage who have a delayed menopause. In Olch's series of 342 women with cancer of the breast first coming to medical attention after the age of fifty, 54.7 per cent were still menstruating at the time of observation or had passed through the menopause after they were fifty. To put it another way, almost five times as many women in this group had a delayed menopausal age as compared to a series of normal women.

Olch believes this difference is too striking to be disregarded and is forced to the conclusion that it must be a factor to be considered in the etiology of this disease in older women. He refers to the published reports of Crossen and Crossen (37) and Crossen and Hobbs (38), who have shown a high incidence of delayed menopause in adenocarcinoma of the body of the uterus, and proposes that prophylactic artificial menopause should be offered to those women menstruating beyond any arbitrary age chosen, forty-eight or fifty, irrespective of palpable breast damage.

While the estrogenic hormone appears above all else to be a growth hormone, it has a marked effect on tissues not primarily reproductive. Skeletal alterations have been induced by it, perhaps supplying an explanation for certain bone metastases. Because the endocrine relation of pituitary, ovary, uterus, and mammary glands is now well established, the question at once arises, must we irradiate the pituitary as well. Allen (34) describes a female mouse that had five cancerous nodules of the mammary gland, granulosa-cell tumors in both ovaries, a pituitary gland fourteen times as large as normal, and a cystic and hyperplastic uterus. Pendergrass (39) irradiates the pituitary after menstruation has ceased.

If we are to recommend irradiation castration on experimental and clinical evidence, it must be done with the full understanding that there are several stimuli that will induce cell division in tissues in which growth is normally dominated by hormones. This knowledge will help in some measure to explain the failures of castration and forcefully remind us that cancer growth and its cure continue to be a complex matter.

In conclusion, while there is much evidence that irradiation has a singular place in the treatment of mammary breast cancer, its niche cannot definitely be assigned until things within the control of the surgeon and radiation therapist become stabilized.

SUMMARY

1. Any surgeon who does less than a radical operation in curable breast cancer is not giving his patient a sporting chance for a fair recovery.

2. A series of grade III tumors (CI PI) receiving postoperative irradiation shows a far higher five-year cure rate than those not receiving irradiation.

3. A series of patients with CII PII cancers in which inadequate operation had been done lived four times as long, having had irradiation, than those who were not irradiated.

4. Irradiation in recurrent and inoperable breast cancer helps to prolong life in relative comfort in a few patients for a few years.

5. A serious trial of preoperative irradiation, particularly for tumors of the breast in young women, is advocated as a possible means of increasing the cure rate of the CI PI group.

6. The facts at hand in regard to the benefit from roentgen castration are discussed. The advisability of inducing an artificial menopause in women over fifty

as a preventive of the development of mammary cancer is presented.

465 Beacon St., Boston, Mass.

BIBLIOGRAPHY

1. QUICK, D.: Care of the Cancer Patient, New York State J. Med. **33:** 975–984, Aug. 15, 1933.
2. HICKEN, N. F.: Mastectomy: Clinical Pathologic Study Demonstrating Why Most Mastectomies Result in Incomplete Removal of the Mammary Gland. Arch. Surg. **40:** 6–14, January 1940.
3. O'BRIEN, F. W.: Skin Metastasis in Post-Operative Irradiated Breast Cancer. Radiology **30:** 437–438, April 1938.
4. SALTZSTEIN, H. C.: Average Treatment of Cancer. J. A. M. A. **91:** 465–470, Aug. 18, 1928.
5. BATSON, O. V.: Function of Vertebral Veins and Their Rôle in Spread of Metastases. Ann. Surg. **112:** 138–149, July 1940.
6. WHITE, W. C.: Irradiation as an Aid to Surgical Treatment of Cancer of the Breast. J. A. M. A. **110:** 261–265, Jan. 22, 1938.
7. KEYNES, G.: Place of Radium in the Treatment of Cancer of the Breast. Ann. Surg. **106:** 619–630, October 1937.
8. SIMMONS, C. C., TAYLOR, G. W., AND WELCH, C. E.: Carcinoma of the Breast: End-Results, Massachusetts General Hospital, 1930, 1931, and 1932. Surg., Gynec. & Obst. **69:** 171–177, August 1939.
9. FITZWILLIAMS, D. C. L.: Plea for a More Local Operation in Really Early Breast Carcinoma. Brit. M. J. **2:** 405–408, Sept. 28, 1940.
10. CUTLER, MAX: Transillumination as an Aid in the Diagnosis of Breast Lesions. Surg., Gynec. & Obst. **48:** 721–729, June 1929.
11. ADAIR, F. E.: Effect of Preoperative Irradiation in Primary Operable Cancer of the Breast. Am. J. Roentgenol. **35:** 359–370, March 1936.
12. COUTARD, H.: Results and Methods of Treatment of Cancer by Radiation. Ann. Surg. **106:** 584–598, October 1937.
13. MELNICK, P. J., AND BACHEM, A.: Time Factor in the Irradiation of Malignant Tumors. Arch. Path. **23:** 757–792, June 1937.
14. MELNICK, P. J.: Histologic Changes in Tumors Implanted with Radon Seeds. Proc. Third Internat. Cancer Congress, 1939.
15. HALLEY, E. P., AND MELNICK, P. J.: Preoperative Irradiation in Carcinoma of the Breast: Histologic Study. Radiology **35:** 430–438, October 1940.
16. SPEAR, F. G., AND GLÜCKSMANN, A.: Effect of Gamma Radiation on Cells in Vivo: Spaced Radiation. Brit. J. Radiol. **14:** 65–76, February 1941.
17. QUICK, D.: Radiation in Primary Operable Breast Cancer. J. A. M. A. **101:** 2091–2096, Dec. 30, 1933.
18. LENZ, M., FRANTZ, V. K., AND KASABACH, H. H.: Prophylactic Roentgenotherapy for Carcinoma of the Breast. New York State J. Med. **34:** 881–887, Oct. 15, 1934.
19. GRAVES, S. C.: Carcinoma of the Female Breast: Interval Report on Results of Treatment. New England J. Med. **225:** 57–61, July 10, 1941.
20. WOLFER, J. A.: Book Review. Surg., Gynec. & Obst. **71:** 534–535, October 1940.
21. PACK, G. T., AND LIVINGSTONE, E. M.: Treatment of Cancer and Allied Diseases. Vol. 1, New York & London, Paul B. Hoeber, Inc., 1940.
22. HARRINGTON, S.: Results of Radical Mastectomy in 5,026 Cases of Carcinoma of the Breast: Various Clinical and Pathologic Features Which Influence Prognosis. Pennsylvania M. J. **43:** 413–427, January 1940.
23. HAAGENSEN, C. D.: Dossier of Panel Discussion on Carcinoma of the Breast. American Roentgen Ray Society, 1941, p. 22.
24. PORTMANN, U. V.: Personal communication.
25. SCHINZINGER, VEBER: Carcinoma Mammae. Verhandl. d. deutsch. Gesellsch. f. Chir. **18:** 28–29, 1889.
26. BEATSON, G. T.: On the Treatment of Inoperable Cancer of the Mamma. Lancet **2:** 104–107, 1896.
27. THOMSON, A.: Analysis of Cases in Which Oophorectomy Was Performed for Inoperable Carcinoma of the Breast. Brit. M. J. **2:** 1538–1541, Nov. 8, 1902.
28. LETT, H.: Analysis of 99 Cases of Inoperable Carcinoma of the Breast Treated by Oophorectomy. Lancet **1:** 227–228, Jan. 28, 1905.
29. AHLBOM, H.: Castration by Roentgen Rays as an Auxiliary Treatment in the Radiotherapy of Cancer Mammae at Radiumhemmet, Stockholm. Acta radiol. **11:** 614–633, 1930.
30. DRESSER, R.: Effect of Ovarian Irradiation on Bone Metastases of Cancer of Breast. Am. J. Roentgenol. **35:** 384–388, March 1936.
31. LATHROP, A. E. C., AND LOEB, L.: Further Investigations on the Origin of Tumors in Mice. On the Part Played by Internal Secretion in the Spontaneous Development of Tumors. J. Cancer Research **11:** 1–19, 1916.
32. CORI, C. F.: Influence of Ovariectomy on Spontaneous Occurrence of Mammary Carcinoma in Mice. J. Exper. Med. **45:** 983–991, June 1927.
33. LACASSAGNE, A.: Hormonal Pathogenesis of Adenocarcinoma of the Breast. Am. J. Cancer **27:** 217–228, June 1936.
34. ALLEN, E.: Ovarian Hormones and Female Genital Cancer. J. A. M. A. **114:** 2107–2114, May 25, 1940.
35. FRANK, R. T., GOLDBERGER, MORRIS A., AND SALMON, U. J.: Estrogenic Substances in Blood and Urine after Castration and Menopause. Proc. Soc. Exper. Biol. & Med. **33:** 615–616, January 1936.
36. OLCH, I. Y.: Menopausal Age in Women with Cancer of the Breast. Am. J. Cancer **30:** 563–566, July 1937.
37. CROSSEN, H. S., AND CROSSEN, R. J.: Amenorrhea; Menorrhagia; Metrorrhagia; Delayed Menopause. Am. J. Surg. **33:** 345–368, September 1936.
38. CROSSEN, R. J., AND HOBBS, J. E.: Relationship of Late Menstruation to Carcinoma of the Corpus Uteri. J. Missouri M. A. **32:** 361–363, September 1935.
39. PENDERGRASS, E.: Dossier of Panel Discussion on Carcinoma of the Breast. Am. Roentgen Ray Society, 1941, p. 20.

Pathology of the Breast[1]

JOHN W. BUDD, M.D.
Los Angeles, Calif.

FROM A PRACTICAL standpoint, diseases of the breast can be classified into two great groups: innocent and malignant. It seems important to recognize the mechanisms by which the benign lesions are derived and to study the relationship they bear to malignant neoplasms.

The variety of changes which occur within the lobular unit of breast structure is of special interest. This unit in the resting mammary gland is composed of the terminal twig of a duct with a small cluster of follicles about it. All are surrounded by a specialized mucoid connective tissue which forms the intralobular stroma. This is sensitized to the estrogenic hormones and responds to stimulation with the epithelium. Surrounding the unit is a band of denser connective tissue, the interlobular stroma. The epithelial lining of the smaller ducts, ductals, and end pieces, as well as of the acini of functioning tissue, is a double layer of cells. The inner layer varies from cuboidal to columnar in shape, while the basal cells are often elongated and fusiform. They are supported by a well defined basement membrane.

BENIGN PROCESSES

Breast tissue can respond to irritation or stimulation in a very limited manner. The reaction is characterized by (1) proliferation of cells (hyperplasia), (2) functional differentiation, and (3) involution. The possibility that all of the benign conditions, which masquerade under a confusing terminology, represent aberrations of this hyperplasia-involution cycle requires elucidation. The following factors seem important for an understanding of this matter.

Mammary tissue may respond to stimuli as isolated units, not all the units reacting in the same degree. Hyperplasia may involve either epithelium or stroma alone, or both in combination. It may be focal, located principally in the epithelium of ducts or in the epithelium at the margins of a lobule. The two layers of cells may proliferate uniformly or may vary in their proportions.

Functional differentiation is at times abnormal, and a serous, milky, or thick greasy secretion may be formed in the acini and ducts, the last especially near the nipple.

Involution may be incomplete, allowing foci of unusual cellularity to persist, or it may result in dilatation of follicles in hyperplastic foci. It may be carried to an extreme, producing scars of dense hyaline devoid of epithelial elements.

The structure may be further complicated by retrograde changes, as necrosis, hemorrhage, fatty metamorphosis, liquefaction, or infiltration with chronic inflammatory cells. Infection by a low-grade pyogenic organism may occur, especially in cystic zones.

Since the structure of the breast is never a static one but is progressing from moment to moment, it is apparent that the number of morbid anatomical pictures resulting from the operation of these processes is almost unlimited. Fairly well defined entities, however, are recognized when a process of a particular type is viewed at a specific moment. Thus, one sees focal areas which may be composed of lobules of perfectly normal breast tissue that are out of tune with the rest of the structure as the result of excessive reaction or failure of involution. If the connective tissue has primarily responded to the stimulation, the appearance is that of fibroadenoma. Focal hyperplasia of ductal

[1] From the Los Angeles Tumor Institute, Los Angeles, Calif. Read before the Radiological Society of North America, at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

epithelium results in intraductal polypoid growth progressing to larger papillomas, while a basilar epithelial reaction may actually invade adjacent stroma even beyond the lobular unit. In this instance, spindle-shaped basal cells may predominate, forming dense nodules of scirrhous hyperplasia. These focal processes, when once initiated, seem to go on to the formation of discrete nodules. In addition to the development of these entities in localized segments of the breast, it is usual to find changes of lesser intensity elsewhere in the organ.

Diffuse reactions may be observed when the predominant activity has been proliferation. The enlarged cellular lobules, fibroglandular foci, intraductal polypi, and zones of sclerosing adenomatosis produce the morbid anatomical picture of mazoplasia or Schimmelbusch's disease. There is usually some element of involution with cystic changes in addition.

In other instances, the dominant influence has been involution, with fibrosis of stroma, atrophy of epithelium, and formation of multiple cysts from the cellular foci, constituting the picture of diffuse cystic disease. This represents the final stage of the proliferative process and probably has a different significance from the hyperplastic phase.

In hyperplasia of the breast, as of other tissues and organs, a stage may eventually be reached where the intensity and autonomy of reaction have assumed neoplastic proportions. The boundary line is indefinable and possibly it is unimportant to attempt to establish one. In epithelial reactions, however, it would seem likely that the process is strictly hyperplasia as long as the two layers of epithelium grow in their normal relationship. Neoplasia might be said, arbitrarily, to begin at the point where growth continues with a single type of cell.

MALIGNANT PROCESSES

The possibility that hyperplasia may progress into neoplasia cannot be denied. Theoretically, malignant transformation might assume either of two forms: sarcoma or carcinoma.

Sarcoma: Fibrosarcoma, which is not a rare type of malignant mammary neoplasm, almost invariably arises in an old fibroadenoma. In the early part of the sarcomatous proliferation a fibroglandular structure may be formed, but the fibrous element is the one which is aggressive and autonomous, and more advanced lesions and metastases are entirely devoid of epithelium. As a class, these sarcomas are of a lower grade of malignancy than carcinoma, but in exceptional cases a very high grade of malignancy may be manifest. Clinically, they are characterized by a rapid enlargement of a previously existing and relatively quiescent nodule, usually in patients over forty years of age.

Carcinoma: The point at which carcinoma can be said to exist is impossible to define. Although from a biological standpoint a very dramatic change has come about, from a structural point of view the malignant proliferation represents a direct continuation from benign hyperplasia. This transformation has not been definitely described in human material. Fekete (1) has described the early appearance of breast cancer in mice where, during the latter part of pregnancy, when cell multiplication should cease and secretion begin, small groups of epithelial cells continued to grow. The proliferation was at first within ducts and alveoli that developed into cords and groups of cells, and later the cells began invading the surrounding connective tissue.

Cancer in the human breast also begins in an epithelial layer. The various forms of hyperplasia—papillary, intraductal, and scirrhous—place the beginning cancer in vastly different situations: on the one hand within the lumen of a duct and on the other already invading interstitial tissues. Progress from this point might be expected to differ widely.

From the focus of origin cancer disseminates to other locations. Growth for a time may remain intra-epithelial. Cancer cells spread through the normal or hyperplastic

epithelial layers, progressively replacing these tissues. The cells may dissect between the two normal layers or completely replace one or the other. Extension along ducts may carry the malignant tissue to distant areas of the breast without further involvement of the organ. As a result of this growth progressively larger accumulations of cancer cells develop within ducts and acini in solid masses, with or without glandular pattern, or in stratified layers with central cores of caseous substance. During this period the cancer can be described as intramural. It is limited by an intact basement membrane and is a localized disease. It is rarely recognized clinically because there are few symptoms and there may be no palpable tumor. The duration of this stage of the disease is highly variable; in a case reported by Muir (2) it lasted ten years.

By the method of intra-epithelial invasion, cancer cells may spread along ducts to the skin of the nipple, where diffuse infiltration through the epidermis produces the anatomical picture of Paget's disease.

Sooner or later cancer cells may break through the basement membrane of the ducts or alveoli to invade the interstitial tissues. Whether this is due to ameboid activity of the cells or mechanical pressure from crowding, it can happen at any point and at any time. Cancer invading the interstitial tissues constitutes the extramural stage of growth, and the usual clinical picture is now fully developed. The invading cancer cells always stimulate fibroblastic activity and if the tissues of the host can react sufficiently the result is a scirrhous type of carcinoma. The loose connective tissue of the breast offers less resistance and there is but a narrow barrier between connective tissue spaces and lymphatics. Spread throughout a large area may quickly develop after lymphatic invasion.

Since the phase of intramural growth represents a localized malignant process, it is unfortunate that only approximately 2 per cent of carcinomas of the breast are treated in this stage. The other 98 per cent represent more advanced disease and obviously have a poorer prognosis.

In estimating prognosis, the anatomical type of carcinoma would seem to be of less importance than the extent of the disease. Estimation of the stage of the disease is a microscopic as well as a gross feature of pathological study. A scirrhous tumor, for instance, always indicates a stage of interstitial infiltration and hence is a more advanced form. Therefore, scirrhous tumors can hardly be looked upon as favorable. Medullary carcinoma where the growing cells are confined to dilated ducts may show only intramural growth and hence be favorable. Where medullary masses of cancer cells develop in interstitial tissues due to very rapid growth or inability of the host's tissues to react, the prognosis is extremely unfavorable. The extent or stage of disease remains the best yardstick for measuring prognosis if one interprets morphology in these terms.

SUMMARY

1. Proliferative processes affecting the breast are divisible into two groups: hyperplasia or benign processes, and neoplasia or malignant processes.

2. The important elements are the two layers of epithelial cells and the specialized connective-tissue stroma.

3. Irregularities of the hyperplasia-involution cycle are described which account for the development of the multitude of morbid anatomical pictures of benign breast disease.

4. A proliferative process in the breast can be regarded as hyperplasia only so long as the double-layered epithelial cells grow in symbiosis. Neoplasia may arbitrarily be defined as beginning in epithelial lesions when these two layers of differentiated cells cease to be formed and growth is of a uniform cell type. Malignant neoplasms developing in fibroglandular hyperplasia are composed essentially of the connective-tissue element.

5. Early breast carcinoma is repre-

sented by a stage of intra-epithelial growth limited by intact basement membranes.

6. The anatomical type of mammary carcinoma may depend upon the nature of the hyperplastic process in which the neoplasm originated as well as its manner of growth, stage of disease, and host resistance to infiltration.

REFERENCES

1. FEKETE, ELIZABETH: A Comparative Morphological Study of the Mammary Gland in a High and Low Tumor Strain of Mice. Am. J. Path. **14:** 557–578, September 1938.

2. MUIR, ROBERT: Pathogenesis of Paget's Disease of the Nipple and Associated Tumors. Brit. J. Surg. **22:** 728–735, April 1935.

1407 S. Hope St., Los Angeles, Calif.

Preoperative Irradiation of Breast Cancer[1]

ALBERT SOILAND, M.D.

Director, Los Angeles Tumor Institute

IN THIS MODERN age we are prone to be more interested in knowing what the future holds than in mulling over the statistics of ancient history. Nevertheless, we ventured a few remarks about cancer of the breast in 1900, which are referred to in articles 1, 2, and 3 in the appended bibliography.

Preoperative and postoperative irradiation has always been an acutely controversial subject and continues to be one of lively debate wherever cancer of the breast is a topic for discussion. As a result of these debates, I would venture the guess that radiologists are about equally divided in their opinion, pro and con; that surgeons are approximately 5 per cent for preoperative x-ray therapy, 35 per cent for postoperative irradiation, and 60 per cent for none at any time. In 1928, I submitted the question to a dozen or more personal friends, outstanding American surgeons. Their replies, which were favorable, are recorded in reference 6.

Prior to the time of reliable cancer statistics, as inaugurated by the American College of Surgeons, it was impossible to calculate the value of case records as offered by many, including ourselves. I did attempt to analyze the clinical course of 550 patients with cancer of the breast of every description, who had received x-ray treatment at our hands. This analysis (4) was presented before the fourth meeting of the Northern Society for Medical Radiology in Helsingfors, Sept. 1, 1925, and covered the period 1915–23, inclusive.

Since that time we have consistently maintained our belief in radiation therapy for breast cancer and have kept the subject actively alive before the medical profession. In 1921, Doctor William E. Costolow joined our staff and carefully reviewed our past records (8). He has continued this study as new material and added experience warranted. In 1926, Doctor Orville N. Meland joined us, bringing with him a substantial surgical background, which has been of great assistance in clarifying our records (11, 12). From a study of our material, as seen in the accompanying tables, I feel warranted in concluding that, while in the operable group irradiation alone may not yield so many successful five-year results as surgery alone, preoperative irradiation *plus* surgery has definitely proved superior to any other known method of therapy. Postoperative irradiation has sometimes accomplished the impossible, but ordinarily is helpful only as a palliative measure in local recurrences. Since surgery has already removed all the buffer tissue upon which the x-ray must rely for its sustained effects, its scope is limited.

During our many years of medical activity, we have seen hundreds of patients exhibiting every known clinical evidence of breast cancer, but lacking the necessary microscopic verification and classification. A goodly number of these cases have responded to radiation therapy alone. This is an accepted fact which can be substantiated by every experienced radiologist. We are as cognizant of the importance of authentic microscopic findings in order to outline accurately the necessary radiation régime, as are our surgical confreres. Altogether too large a number of patients, however—of the conscientious-objector-to-surgery-type—will not permit even an aspiration biopsy.

The greatly desired open teamwork between surgeon and radiologist has improved of late, but we still seem far removed from a common understanding. Sufficient progress has been made, however, to augur well for the future.

There is much truth in the old admoni-

[1] Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

TABLE I: RESULTS OF TREATMENT IN 63 OPERABLE CASES OF CANCER OF THE BREAST, GROUP I*

Type of Treatment	Total Cases	Lost	Dead	Five-Year Survivals	Deaths after Five Years
Preoperative x-ray and operation	24	1	7	16 (67%)	3(12, 16, 17 years)
X-ray therapy and radium needles interstitially	11	0	4	7 (67%)	4(6, 6, 8, 10 years)
X-ray therapy alone	28	1	14	13 (46%)	7(6, 6, 8, 9, 9, 15, 15 years)

* Without axillary nodes.

tion that a speaker must size up his audience and be able to adapt himself to their verbiage and ideas. This does not always work out well unless consistently followed, as is demonstrated by an outstanding American surgeon who, in a recent address before a radiological group, praised preoperative x-ray therapy in breast cancer, and then, shortly thereafter, reversed his opinion before a surgical group and unmercifully condemned irradiation.

Were we permitted to include in our tabulations all patients with clinically certain but microscopically unproved cancer of the breast who have remained symptom-free five years or more, a very different story could be narrated. Since this is scientifically impossible, we must abide by a strictly correct and conservative statistical enumeration. It is my personal opinion, however, that the patient of any age with a small nodular breast and questionable axillary nodes will respond equally as well, and probably better, to a skillfully planned and thoroughly executed course of x-ray therapy than to surgery alone. It must be kept constantly in mind that nothing short of complete x-ray sterilization should be permitted, whether the patient is referred for preoperative x-ray therapy or for x-ray therapy alone. To sterilize completely a suspected field means that every cancer cell in and about the terrain must be killed, and our job, first, last, and always, is to destroy cancer cells by every available method. We must also be on the alert at all times to give to each patient the utmost in individual care, whether the big boggy breast or the small under-developed breast is under treatment. The régime must be in strict clinical conformity with all the individual variations in the patient herself as well as in the treatment factors. As has been pointed out by many of us in the past, so-called radioresistant tumors are quite frequently amenable to radiation and it is not necessary or desirable to produce a radiation necrosis of the skin surface in order to obtain maximum therapeutic values. Proper filtration will obviate this.

It is comparatively simple to build transformers into the multi-million volt region, but it is extremely difficult to construct an x-ray tube which will yield a steady emission rate at one million volts. This has been the experience of everyone, including ourselves, who has been active in research work with all x-ray voltages since their earliest therapeutic availability. There are, they say, several "biggest x-ray tubes in the world" located in various parts of the United States, but in so far as I am able to determine, none of them has been in operation for a sufficiently long period of time for the evaluation of results, nor have any of them brought about any sustained therapeutic help which can be accepted as strikingly different or vastly superior to what has heretofore been obtained by lower voltage beams down to the 500–600 kv. range. This fact has been brought out on many former occasions. We refer to the pioneer research work of Lauritsen and associates of the California Institute of Technology.

Doctor Meland (13) has pointed out in a recent survey that, since 30 per cent is the accepted five-year recovery rate for surgically treated patients and our records

TABLE II: RESULTS OF TREATMENT IN 120 OPERABLE CASES OF CANCER OF THE BREAST, GROUP II*

Type of Treatment	Total Cases	Lost	Lived Less than Five Years	Lived More than Five Years	Cancer Deaths after Five Years
Preoperative x-ray and operation	(*a*) 30	1	10	19 (65%)	1(7 years)
	(*b*) 23	1	13	9†(39%)	5(6, 7, 8, 9, 10 years)
	53	2	23	28 (54%)	
X-ray therapy and radium needles interstitially	27	3	9	15 (55.5%)	5(6, 6, 6, 7, 8 years)
X-ray therapy alone	40	4	26	10 (25%)	5(6, 6, 6, 10, 10 years)

* With axillary nodes.
† Three living with cancer.
(*a*) Tumor movable, with or without skin attachment; slight ulceration at times; nodes low in axilla.
(*b*) Tumor movable or partly fixed; skin attachment; may be ulcerating; thickness in the supraclavicular region. Questionable operable class.

show a five-year survival of 47 per cent, it is apparent that preoperative irradiation has increased longevity by 17 per cent. With approximately 3,400 case records in our files of patients treated for cancer of the breast, it seems pathetic that only 233 were referred for preoperative irradiation.

1407 S. Hope St., Los Angeles, Calif.

BIBLIOGRAPHY

1. SOILAND, ALBERT: Case of Carcinoma of the Breast Treated by X-rays. So. Calif. Pract., April 1902.

2. SOILAND, ALBERT: Plea for Combining the X-rays with Surgery in Mammary Carcinoma. So. Calif. Pract. **20:** 445–450, 1905.

3. SOILAND, ALBERT: The Surgeon and the X-rays. Calif. Med. & Surg. Reporter, January 1905.

4. SOILAND, ALBERT: Cancer Problem of the Female Breast. An Analysis Based upon 25 Years Experience in Radiation Therapy. Acta radiol. **4:** 391, 1925.

5. SOILAND, ALBERT: Treatment of Cancer of the Breast from the Viewpoint of a Radiologist. Brit. J. Radiol. **31:** 469–476, December 1926.

6. SOILAND, ALBERT: Present Status of Roentgen-Ray Therapy in Breast Malignancy. Radiology **13:** 388–391, November 1929.

7. SOILAND, ALBERT: Cancer of the Breast. J. Cancer Research **14:** 128–133, March 1930.

8. COSTOLOW, W. E.: Recent Advances in Radium Therapy in Breast Cancer. Am. J. Roentgenol. **25:** 247–249, February 1931.

9. SOILAND, ALBERT: Management of Cancer of the Breast. Southwestern Med. **16:** 493–494, December 1932.

10. SOILAND, ALBERT: Management of Breast Cancer. J. A. M. A. **98:** 786–788, March 5, 1932.

11. MELAND, O. N.: Experiences in Interstitial Irradiation of Carcinoma of Breast. Am. J. Roentgenol. **28:** 223–228, August 1932.

12. MELAND, O. N.: Place of Interstitial Irradiation in Cancer of the Breast. Am. J. Roentgenol. **35:** 348–358, March 1936.

13. MELAND, O. N.: Influence of Radiation on Longevity in Cancer of the Breast. Delivered before the Section on Radiology, American Medical Association, Cleveland, June 6, 1941.

Selection of Cases for Surgery in Cancer of the Breast[1]

ALSON R. KILGORE, M.D.

San Francisco, Calif.

THE KIND INVITATION to participate in this symposium brings high honor and also great responsibility, both of which I keenly appreciate. Before this audience, the technical aspects of breast surgery may be omitted as of minor interest, and the technic of roentgen therapy can be better stated by others.

The selection of treatment does, however, deserve our attention. Choice between irradiation and operation as the primary therapy should, it seems to me, be decided definitely at the outset in each case, and the indications for selection of operation should be much more restricted than is now the case in the practice of many men. This does not mean that both forms of treatment should never be used in some cases. Preoperative and postoperative irradiation in primarily surgical cases has been discussed today by others and I shall attempt no evaluation of such combination. My criticism is of ill-considered selection of patients for primary surgery, and of the too frequent but usually inadvisable operative interference in the course of primary roentgen therapy.

We are doubtless all agreed that the standard radical operation offers the best chance of permanent cure for carcinoma still clinically confined to the breast. This includes tumors which can be diagnosed as malignant only on exploration and those with relatively early skin retraction but without evidence of extension beyond the breast. Patients with palpable neck metastases, on the other hand, or with x-ray evidence of chest or bone involvement, are certainly inoperable in the sense that no prolongation of life may be expected from surgical interference. That these unfortunates may now be offered real help is one of the great achievements of modern radiology. And it is my conviction that surgical hands should be kept off throughout the course of management in these cases. In the first place, while this is not susceptible to statistical proof, I believe these patients do better generally, have less discomfort, less arm edema and disability, if no surgery is done. In the second place, operation tends to divert the mind of the patient and often that of her doctor from complete dependence on radiation, so that a less thorough job is likely to be done. Finally, irradiation therapy for cancer of the breast should be and usually is a procedure as major as radical surgery and, unless something worth while is to be accomplished, it is undesirable to put patients through two major procedures instead of one.

We select, therefore, surgery as the primary method of treatment for clinically local cancer, and irradiation as the primary therapy for cancer which has demonstrably spread beyond the limits of successful surgical extirpation. Quite obviously cure is just as impossible when the amount of cancer beyond surgical reach is microscopic as when nodes can be felt above the clavicle or shadows of metastases can be seen in lung fields. If we can recognize reliable clinical signs that such microscopic spread has occurred, we should regard these also as evidence of inoperability and select irradiation as the primary method of therapy.

The extent of axillary involvement is perhaps the most significant index of prognosis, even more than the pathological grade of the tumor, for it is a direct expression of metastasizing potential. If the axillary lymphatics are filled, then others will doubtless be invaded as well—chest wall, neck, etc. The chances of remaining clinically well for five years after operation are about 70 per cent for patients without proved node involvement, about

[1] Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

20 per cent for those with one node invaded, and about 5 per cent for those with a chain of metastases. Without doubt most, if not all, of this last group would live as long without operation. While well justified, therefore, in operating for a 20 per cent chance on the patient with minimal axillary involvement, we should like to be able to recognize the more aggressively metastasizing cancer, and for it elect the conservative course of treatment.

Unfortunately, the determination of operability is not so easy as this sounds. Palpation of the axilla is notoriously inaccurate in identifying metastases. In fact, about 30 per cent of supposedly cancerous lymph nodes felt before operation are found to be innocent, while 40 per cent of patients considered free from axillary involvement prove on clinical examination to have metastases. There are, however, certain details to be observed which should make it possible to improve those percentages. I have not seen a hard node more than 2 cm. in apparent diameter prove innocent, nor have I ever seen a node of this size prove to be the only one involved. Meticulous pathological examination has always disclosed other metastases. Fixation of enlarged nodes to the chest wall is a reliable sign of extensive lymphatic involvement.

Size of the primary tumor in the breast is of relatively little significance. We have all seen large masses, even with skin involvement or actual ulceration, prove to be colloid or comedo adenocarcinoma without axillary spread. Discrete skin metastases, however, are a clear indication of extensive lymphatic spread with uniformly bad prognosis. The same is true of the so-called orange-peel skin, the very presence of which is due to diffuse lymphatic block by cancer. The presence of either orange-peel skin or of discrete skin metastases should place patients in the inoperable group. Similarly, edema of the supraclavicular fossa, to say nothing of edema of the arm, furnishes clear evidence of spread beyond the reach of surgery.

Fixation of the tumor to the chest wall is another indication that operation cannot cure. It seems to me that the concept that irradiation can make an inoperable case operable because it makes a fixed tumor movable or because it causes multiple large axillary nodes to regress is an error. The situation is not comparable with that of fixed cancers of the colon, where firm anchorage is often inflammatory rather than malignant. In the breast the fixation is due to actual invasion by new growth. Regardless of clinical appearances, irradiation therapy cannot make a local carcinoma out of one that has spread beyond the breast. If it were possible to kill all cancer outside the breast it would be even easier to kill it all in the breast, and surgery would be unnecessary.

So far we have been speaking of the radical operation. I am equally convinced that simple mastectomy, with rare exceptions, has no place in the therapy of cancer. It is not enough for the curable patient and it contributes nothing of adequate value to most of the incurable.

It is argued that if the axilla is not involved, removal of its contents is unnecessary and simple mastectomy will cure just as well. This reasoning fails to take into account three facts: (1) Pathological examination of axillary lymphatics is by no means 100 per cent accurate. Serial sections usually are not made and, judging from the small deposits often found occupying only one edge of a node, many must be missed in sections which happen to be cut through uninvolved areas. And it is by no means a simple matter to be sure that all axillary nodes have been found and examined. (2) Even if one node is involved, chances of cure by the radical operation are still 20 per cent, while with simple mastectomy they are zero. (3) The radical operation is not just a simple mastectomy plus an axillary dissection, but includes removal of the pectoral muscles and a wide zone of fascia, structures likely to contain microscopic cancer even before it reaches the axilla. It seems to me that the question of the necessity of the radical operation for even the earliest cancers of

the breast has been settled and should remain settled.

On the other hand, in cases recognized as incurable, one often hears a simple mastectomy advocated to prevent ulceration. We have all heard this seriously proposed when the patient's death appeared about as imminent as ulceration. One need not argue to a group of radiologists that x-ray therapy, in most cases, will prevent ulceration just as effectively. In fact, it will usually cause even extensive ulceration to heal.

About the only circumstances which justify a simple palliative mastectomy are (1) large or ulcerated tumors which prove radioresistant; (2) large or ulcerated tumors in the very old, for whom a more or less strenuous course of radiation therapy is undesirable; (3) bulky tumors in large breasts, which the radiologist may desire to have out of the way for technical reasons.

Concluding, then, we should survey each case of cancer or probable cancer of the breast and determine in the first instance whether radiation or surgery shall be the primary method of therapy and then adhere to that choice.

The selection of surgery should be more restricted than it has been and should exclude not only cases with demonstrable neck or distant metastases but also cases with discrete skin metastases, orange-peel skin, fixation of tumor to the chest wall, supraclavicular edema, multiple large or fixed axillary nodes, and perhaps even a single hard node over 2 cm. in diameter.

Simple mastectomy, with few exceptions, has no place in treatment of breast cancer.

490 Post St., San Francisco, Calif.

Radiation Osteitis of the Ribs[1]

LESTER W. PAUL, M.D., and ERNST A. POHLE, M.D., Ph.D.

Associate Professor of Radiology and Professor of Radiology, University of Wisconsin Medical School, Madison, Wis.

THE RADIOSENSITIVITY of bone has been regarded as fairly low, especially in the adult. A definite distinction must be made, however, between the acute and the late reaction. Considering the effect of repeated series of exposures to roentgen rays on other tissues, it is not surprising to find similar reactions in bone. Perhaps the first report in American literature of radiation injury to the adult skeleton following therapeutic exposure to roentgen rays was published by Dalby *et al.*, in 1936 (5). They observed fractures of the femoral neck as a complication of irradiation for pelvic growths.

During the last ten years we have seen similar changes in the ribs of patients who had received prophylactic postoperative irradiation after removal of a breast for cancer. As the radiological literature contains but occasional mention of this reaction we will report our experience in detail.

REVIEW OF LITERATURE

The effect of roentgen rays and radium on growing bone has been studied and reported by numerous investigators (6, 10, 13, 15, 17). The accumulated experience, both clinical and experimental, indicates that irradiation of young, rapidly growing children causes more or less retardation in the growth of bones and other structures in the region exposed to the rays and that the degree and duration of such inhibition are governed by the age of the subject and the dose of radiation.

While adult bone generally has been thought to be one of the least sensitive of tissues to radium or x-rays, there is growing evidence that severe damage may develop as a result of heavy therapeutic irradiation. The action of radium in producing necrosis of the mandible in watchdial painters is well known and will not be reviewed here (4, 9, 14). The observations of Regaud (18) and others concerning necrosis of bone following treatment of ulcerated cancers of the mouth are pertinent, but in these instances, while irradiation was held to devitalize the bone, the condition was believed to remain latent until infection developed and caused active necrosis.

The conclusions reached by Ewing (7) after a study of three cases of bone necrosis following heavy irradiation for bone tumor are significant. He states that: (1) Moderate radiation greatly reduces the growth capacity of bone cells and the bones unite after fracture by the formation of an unusually hard callus. (2) After more severe radiation, such as falls within the upper limits of therapeutic measures now commonly employed (1926), there may be established a progressive productive osteitis which may cause marked thickening of the shafts, mostly at the expense of the marrow cavity, and in the case of cancellous bone may largely replace the fat and cellular marrow by poorly formed and brittle bone or calcified osteoid tissue. (3) Severe therapeutic radiation of bone produces a peculiar change in the structure and composition of lamellar bone which shows itself by increased fragility and a marked tendency to spontaneous fracture. Under favorable conditions, however, the fractures may slowly heal. After such radiation the bone is nearly devoid of circulation and the periosteal vessels are generally much sclerosed. (4) Heavy radiation renders the shaft of a bone very brittle and prone to spontaneous fracture; the periosteum is injured and a persistent mass of indolent tissue prevents the restoration of function of the limb.

[1] From the Department of Radiology and Physical Therapy, State of Wisconsin General Hospital. Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

TABLE I: FIFTEEN CASES OF RADIATION OSTEITIS

Case	No. of Series of X-ray	Total Radiation to Breast	Duration of Treatment Period	Time from Beginning Treatment to Fracture	Time from End of Treatment to Fracture	Time from Appearance of Fracture to Last Observation	Symptoms Due to Fracture	Radiation Reaction in Lung	Healing of Fracture	Metastasis or Recurrence	Age of Patient	Remarks
1. A. G.	2	3200 r	3 mo.	1 yr. 11 mo.	1 yr. 8 mo.	2 yr. 10 mo.	No	Yes	Yes	?	59	Treatment stopped because of early lung reaction
2. M. M.	5	6000 r	1 yr. 6 mo.	3 yr. 3 mo.	1 yr. 9 mo.	2 yr. 8 mo.	No	No	Yes	No	46	
3. M. B.	2	2600 r	8 mo.	1 yr. 3 mo.	7 mo.	10 mo.	No	No	Yes	Yes	..	
4. E. Z.	6	6300 r	2 yr.	4 yr. 3 mo.	2 yr. 3 mo.	6 mo.	No	No	No	No	48	
5. M. G.	3	4000 r	10 mo.	2 yr. 1 mo.	1 yr. 3 mo.	3 yr.	No	Yes	No	Yes	59	Biopsy of rib done. Tissue unsatisfactory for diagnosis
6. V. C.	5	6400 r	1 yr. 7 mo.	2 yr. 7 mo.	1 yr.	6 mo.	No	No	Yes	No	44	
7. G. C.	5	6600 r	1 yr. 5 mo.	2 yr. 8 mo.	1 yr. 3 mo.	2 yr. 11 mo.	No	No	No	No	53	
8. A. Y.	5	6200 r	1 yr. 8 mo.	2 yr. 8 mo.	5 mo.	1 yr. 4 mo.	No	Yes	No	No	63	
9. E. F.	4	5200 r	1 yr. 5 mo.	2 yr. 5 mo.	1 yr.	1 yr. 2 mo.	No	No	No	No	60	
10. P. O.	5	6400 r	1 yr. 10 mo.	3 yr.	1 yr. 2 mo.	1 yr. 10 mo.	No	Yes	No	No	61	
11. H. S.	6	5600 r	2 yr.	4 yr. 6 mo.	2 yr. 6 mo.	1 yr. 10 mo.	No	No	No	Yes	44	One recurrent nodule treated 2 years ago. Has been well since
12. F. R.	4	5600 r	1 yr. 1 mo.	4 yr.	2 yr. 11 mo.	1 yr.	No	Yes	No	No	32	
13. W. K.	5	6400 r	3 yr.	2 yr. 4 mo.	.....	2 yr. 4 mo.	No	No	No	No	62	One series given after first evidence of rib fracture
14. E. C.	4	3400 to breast, 5400 to other 3	9 mo. 1 yr. 2 mo.	4 yr. 10 mo.	4 yr. 1 mo. 3 yr. 8 mo.	6 mo.	No	Yes	No	No	43	
15. B. Mc.	4	4600 to breast, 5000 to other 3	1 yr. 4 mo.	4 yr.	2 yr. 8 mo.	0	No	Yes	...	No	48	No follow-up after fracture discovered

NOTE: All doses refer to "r" measured in air. Lung reaction appeared before bone changes in all cases where both were present.

More recently, the occurrence of fracture of the femoral neck following irradiation for pelvic tumors has been reported. Baensch (2, 3) described two cases, in one of which histologic examination of the tissues in the fracture area was possible. There was no tumor metastasis but there were a pseudarthrosis and rarefaction of the bone substance with replacement by plentiful connective tissue deficient in blood vessels. Kropp (12) reported a similar case and Philipp (16) described five examples. Dalby, Jacox and Miller (5) reported 14 instances of femoral neck fracture following irradiation for pelvic tumors. In one the head and neck of the femur were removed and no metastatic tumor was found. Strauss and McGoldrick (19) describe four cases of similar nature.

Bade and Küntscher (1) believe that fractures occurring in bones that have been irradiated are often of the so-called "fatigue" or "chronic" type and present experimental evidence to support their view.

From the above reports it is evident that fractures of the femoral neck may occur as sequelae to heavy irradiation for pelvic tumors, apparently due to devitalization of bone and periosteum, and that similar injury may occur in a long bone (7). It is obvious, also, that gross changes may develop in a bone so treated without there being any superimposed infection.

In view of the widespread use of roentgen rays in the treatment of carcinoma of the breast, it is surprising that evidence of damage to the ribs has not been reported more frequently. Jacobsen (11) describes in detail the changes in the lung of one patient following heavy irradiation. In discussing this paper Carty mentions pathological fractures of the ribs as a complication of irradiation and states that these are extremely difficult to differentiate from metastatic lesions. Hodges *et al.* (8) described and illustrated a spontaneous fracture of the inner end of the clavicle four years following irradiation for a carcinoma of the trachea.

ROENTGENOLOGIC FINDINGS

As a routine postoperative procedure with patients under treatment for carcinoma of the breast, it is our practice to obtain roentgenograms of the chest at three- to six-month intervals or whenever the patient returns for treatment or check-up examination. We have found this of value in the early detection of metastasis and pleuropulmonary reactions in the lung secondary to irradiation. Among these cases we have discovered 15 with changes in the ribs which we believe are due to roentgen injury, and these are the subject of the present discussion.

The essential details as to clinical features, dosages employed, and other pertinent factors are listed in Table I. In order to permit an intelligent evaluation of the doses applied, as recorded there, a brief outline of the technic will be given. Patients who do not show metastases at the time of operation receive only three or four series of six exposures each, administered at intervals of three, four, and six months, over three fields: the anterior chest and the supraclavicular and axillary regions. Moderate penetration (H.V.L. in Cu = 0.2 mm.) is used for the chest field, and customary deep therapy radiation (H.V.L. in Cu = 1.05 mm.) for the other areas. The single dose per field is 200 r in air.

Patients with metastases at the time of operation are treated with a four-field technic, both an anterior and a posterior axillary area being exposed instead of a single axillary field. The first course consists of eight exposures followed by series of six exposures with intervals of three, four, five, six, and six months between series. In this respect we follow the example of Holfelder, who found that a reduction in the amount of treatment showed a drop of the five-year survivals from 61.2 to 44 per cent.

A study of Table I shows that 10 patients received total doses to each field of from 5,200 r to 6,600 r over periods ranging from thirteen to thirty-six months. The other

5 received somewhat smaller total doses, the smallest being 3,200 r given over a period of three months; in this patient treatment was discontinued because of the development of reaction in the lung. At varying times after the full course of therapy was given, changes were detectable in the underlying ribs, consisting in pathological fracture or fractures, a variable amount of bone absorption at the edges of the fractures and, generally, absence of reparative change over periods of up to three years. Usually the first roentgen evidence was that due to fracture, manifested by sharp change in alignment of the rib, with or without a fracture line being visible. In some an irregular transverse fissure or line of increased radiotranslucency first appeared. Usually after some months the rarefied zone became more pronounced, leading to well defined defects in the rib shadow measuring up to a centimeter in length. Varying degrees of displacement were encountered. In 4 of the 15, the fractures healed after an interval of ten months. In 10 no healing had occurred even after observation up to three years. In the healed cases the bone at the site of the fracture became somewhat denser than normal. Generally at the time of fracture the bones appeared rarefied and sclerosis, if appearing at all, occurred late and was minimal in degree. In one patient there was no follow-up after the fracture was discovered.

A significant feature was the complete absence of symptoms referable to the fractures in all cases. They were found incidentally on routine chest roentgenography for metastases. In the first few cases the lesions were considered to be metastatic, and one patient received further roentgen therapy directed to the rib lesions. In the remainder the nature of the lesion was recognized, as we had become aware of the possibility from observing the previous cases.

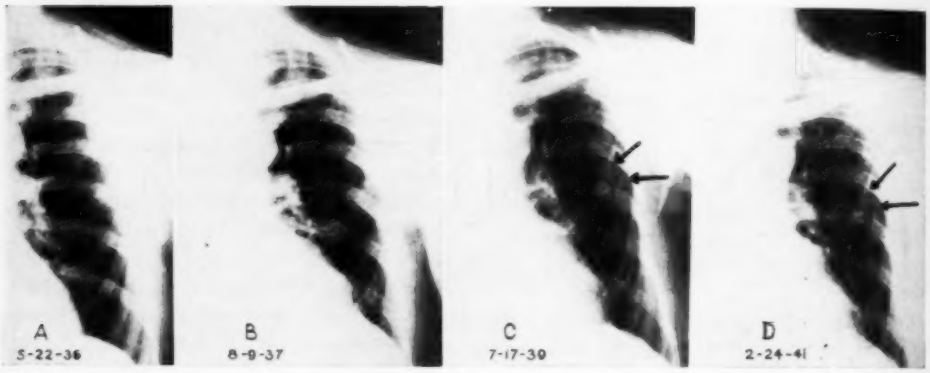


Fig. 1. (M. G.) A. Appearance of left side of chest at the beginning of roentgen therapy. B. Fourteen months later, and five months after completion of therapy (4,000 r given in three series). A small area of pneumonitis is visible in the periphery of the mid-lung field. C. Two years later. Fractures with loss of bone substance are present in the anterior segments of the upper ribs (arrows). D. Nineteen months later than C. No evidence of healing.

All of the lesions were in the anterior or anterolateral segments of the upper ribs, usually the third, fourth, and fifth. In 4 instances, only one rib was involved; in 5 cases two ribs, in 3 cases three ribs, and in 3 others four ribs were involved. When multiple, the changes were in immediately adjacent segments.

DIFFERENTIAL DIAGNOSIS

Only two possibilities need be considered in the differential diagnosis of these lesions, (1) traumatic fracture and (2) metastasis. The first can be ruled out by the absence of a history of injury and lack

of pain. Metastatic involvement is more confusing. A focus of malignant growth may be present in a bone without symptoms. The lesions described were insidious in their development, and the changes were slowly progressive over a period of months. In some of the cases the early changes were not recognized on the films at the original observation. After they became more obvious, review of the earlier roentgenograms showed detectable evidence of beginning disturbance indicating the chronic course of the process.

tion that the fractures are not due to metastasis.

DISCUSSION

At the present time we have no histologic proof for the diagnosis in these cases. Biopsy of a rib was done in one patient. The bone was soft and friable and, in removing a small piece with a biopsy punch, it was crushed so badly that the pathologist was unable to interpret the microscopic appearances satisfactorily. The clinical course and observation over fairly

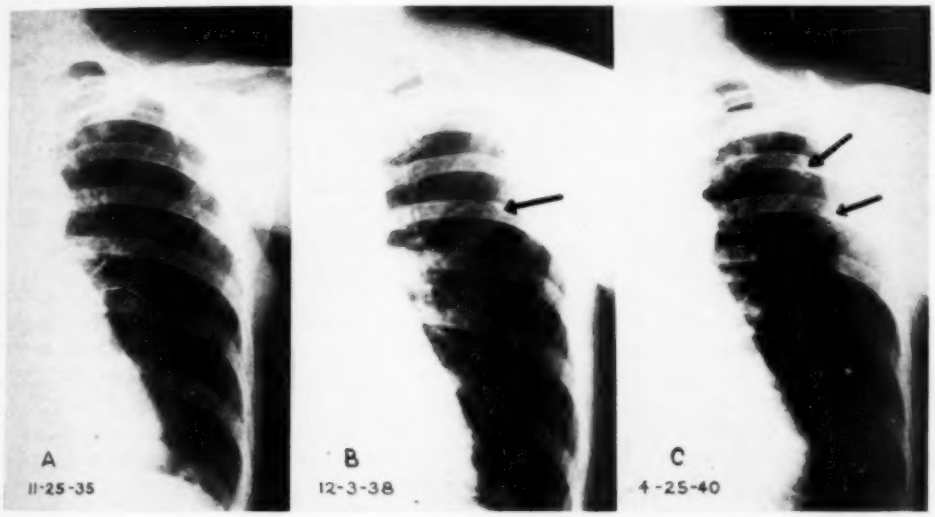


Fig. 2. (H. S.) A. Appearance of left side of chest six months after completion of roentgen therapy (5,600 r given in six series over a two-year period). Lungs and ribs are normal. B. Three years after A. Irregular fracture line now visible in third rib. C. Seventeen months after B. Fracture unhealed and similar lesion present in second rib (arrows).

The location of the lesions is significant. All of them developed in the same area of the chest wall where overlapping of fields might presumably occur or where scattered radiation from the various fields would be at its maximum. The lesions showed a tendency to become stationary after an interval of months and when healing did not occur within a year after the fracture was first noticed, it remained ununited. This lack of progression of destruction and the smoothing off and eburnation of the surfaces are considered acceptable evidence for the correctness of the assumption that the fractures are not due to metastases. Typical cases are illustrated in the accompanying roentgenograms (Figs. 1 to 3).

long periods of time lead us to believe that the lesions were not due to metastases.

As indicated in the brief survey of the literature, external radiation is capable of producing damage to adult bone. Following mastectomy the thickness of the remaining tissues covering the anterior portions of the ribs is small, so that there is little difference in the amount of radiation received by the ribs and that received by the skin. While the total doses, in most cases, were large, the period of treatment

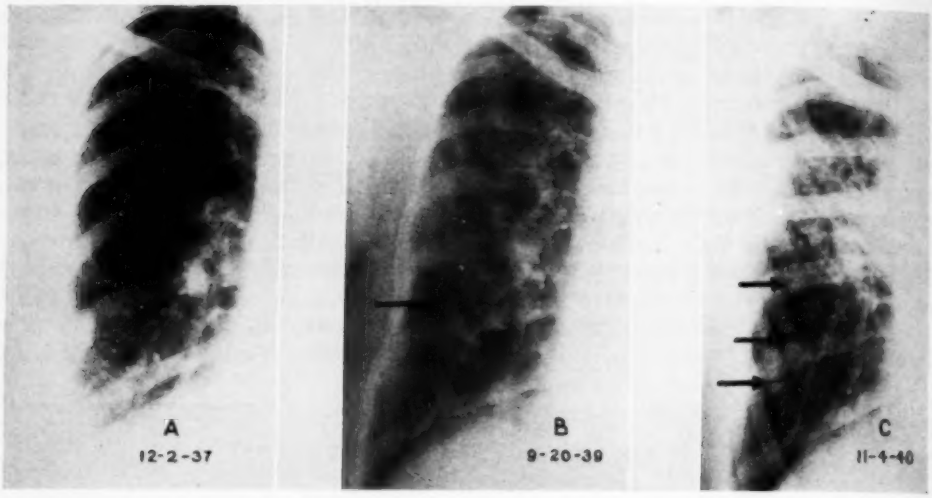


Fig. 3. (A. Y.) A. Appearance of right side of chest at the beginning of roentgen therapy. B. Twenty-two months later and two months after completion of therapy (6,200 r given in 6 series over a period of 20 months). Fairly severe pulmonary reaction now evident. Early fracture visible in one rib (arrow). C. Fourteen months after B. Multiple fractures with bone absorption now evident. Pulmonary changes have become more fibrous. Rib lesions have remained unhealed up to the present time (Nov. 5, 1941).

covered intervals of time up to three years, with an average of one year and five months, so that the effects can be listed as a late reaction. Whether similar lesions could be produced by a large total dose given in a single series, as with the Coutard technic, is not known to us.

The fractures and bone absorption have caused no inconvenience to the patients, so that the injurious effects noted should not prevent the giving of this amount of radiation to the chest if it be deemed necessary. In a long, weight-bearing bone such effects might lead to permanent disability due to failure of bony union after fracture.

SUMMARY AND CONCLUSIONS

1. Following prophylactic irradiation of the chest after operation for carcinoma of the breast, we have seen changes in the underlying ribs which are believed to be due to roentgen injury. These consist in pathologic fracture, rarefaction and absorption of bone at the site of fracture, a tendency to non-union with pseudarthrosis, and an absence of pain or other symptoms associated with the development and course of the lesions. A total of 15 such cases have been observed.

2. The experiences of others as recorded in the literature, and our own, indicate that adult bone can be damaged by external irradiation with roentgen rays and that the sensitivity of bone to such radiation, if applied in repeated series over a period of one or two years, is considerably greater than formerly believed.

University of Wisconsin Medical School
Madison, Wis.

REFERENCES

1. BADE, H., AND KÜNTSCHER, G.: Wirkungen von Röntgenstrahlen auf den Knochen. (Experimentelle Untersuchungen an Hunden.) Fortschr. a. d. Geb. d. Röntgenstrahlen **60:** 235–242, September 1939.

2. BAENSCH, W.: Knochenschädigung nach Röntgenbestrahlung. Fortschr. a. d. Geb. d. Röntgenstrahlen **36:** 1245–1247, December 1927.

3. BAENSCH, W.: Über Spontanfrakturen des Schenkelhalses nach Röntgenbestrahlung. Röntgenpraxis **4:** 716–718, August 1932.

4. BLUM, T.: Quoted by Hoffman.

5. DALBY, R. G., JACOX, H. W., AND MILLER, N. F.: Fracture of the Femoral Neck Following Irradiation. Am. J. Obst. & Gynec. **32:** 50–59, July 1936.

6. DESJARDINS, A. U.: Osteogenic Tumor: Growth Injury of Bone and Muscular Atrophy Following Therapeutic Irradiation. Radiology **14:** 296–308, March 1930.

7. EWING, JAMES: Radiation Osteitis. Acta radiol. 6: 399–412, 1926.
8. HODGES, P. C., PHEMISTER, D. B., AND BRUNSCHWIG, A.: Roentgen Ray Diagnosis of the Bones and Joints, New York, Thomas Nelson & Sons, 1938, p. 120.
9. HOFFMAN, F. L.: Radium (Mesothorium) Necrosis. J. A. M. A. 85: 961–965, Sept. 26, 1925.
10. ISELIN: Ueber Wachstumschädigungen junger Tiere durch Röntgenstrahlen. Fortschr. a. d. Geb. d. Röntgenstrahlen 19: 473–474, 1913.
11. JACOBSEN, V. C.: Deleterious Effects of Deep Roentgen Irradiation on Lung Structure and Function. Am. J. Roentgenol. 44: 235–249, August 1940.
12. KROPP, L.: Ueber Spontanfrakturen des Schenkelhalses nach Röntgenbestrahlungen wegen Uteruskarzinoms. München. med. Wchnschr. 81: 214–215, Feb. 9, 1934.
13. KRUKENBERG, H.: Quoted by Desjardins.
14. MARTLAND, H. S., CONLON, P., AND KNEF, J. P.: Unrecognized Dangers in the Use and Handling of Radioactive Substances; with Special Reference to Storage of Insoluble Products of Radium and Mesothorium in the Reticulo-endothelial System. J. A. M. A. 85: 1769–1776, Dec. 5, 1925.
15. PERTHES, G.: Ueber den Einfluss der Röntgenstrahlen auf epitheliale Gewebe, insbesondere auf das Carcinom. Arch. f. klin. Chir. 71: 955–1000, 1903.
16. PHILIPP, E.: Knochenerkrankungen bei wegen Uteruskarzinoms mit Röntgenstrahlen bestrahlten Frauen. Strahlentherapie 44: 363–378, 1932.
17. RECAMIER, D., AND TRIBONDEAU, L.: Quoted by Desjardins.
18. REGAUD, C.: Quoted by Desjardins.
19. STRAUSS, H., AND MCGOLDRICK, J. L.: Fracture of the Femoral Neck Following Roentgen Therapy for Gynecologic Malignancy. Am. J. Obst. & Gynec. 41: 915–934, June 1941.

DISCUSSION OF SYMPOSIUM ON CANCER OF THE BREAST

(Papers by Lowell S. Goin, Ernst A. Pohle and Roland R. Benson, Frederick W. O'Brien, John W. Budd, Albert Soiland, Alson R. Kilgore, Lester W. Paul and Ernst A. Pohle.)

William W. Haggart, M.D. (Denver, Colo.): In the amount of time allotted for this discussion it is impossible to do justice to the large problem of cancer of the breast. We have heard much today in regard to the difference of opinion between the radiologist and the surgeon as to how cancer of the breast should be treated. If, however, one should really analyze our so-called difference of opinion, it would be found to be very slight.

From a treatment point of view I like to divide tumors of the breast into three clinical groups: (1) the benign group, (2) the clinically carcinomatous group, and (3) what I call the biopsy group. In Group 1 we are agreed that irradiation is not indicated. In Group 2 we are, I believe, again agreed that surgery should be used as an adjunct to the treatment; that is, x-ray therapy should be instituted, and, if surgery holds any hope of helping to eradicate the disease, operation should be done, followed up by more irradiation. Into this class also fall the so-called hopeless cases. Here surgery should be suggested only when it is the consensus of opinion that there is some hope of alleviation of symptoms.

The third group presents a much more difficult problem. Many radiologists ask why more preoperative x-ray therapy is not given. I believe that the reason lies in the uncertainty of diagnosis in this large group. Because of the increasing propaganda regarding tumors of the breast we are seeing patients much earlier than formerly, and hence we often cannot make a diagnosis of a malignant tumor without a biopsy. Some recommend aspiration biopsies, but this procedure has not proved especially satisfactory in all clinics. A negative report from an aspiration biopsy apparently means nothing, thus necessitating a repetition of the procedure. I, for one, am very much against repeated trauma to a potentially malignant tumor. I likewise feel that the complete surgical procedure should be carried out at the time of biopsy, thereby avoiding a second anesthesia for the patient, and, above all, preventing the stimulus of repair within a possibly malignant field. With reference to postoperative x-irradiation, I am a firm believer that it should be carried out in most cases.

In conclusion, I believe that the treatment of carcinoma of the breast cannot, and should not, be generalized; that each case is an entity. Treatment should be instituted only after careful consideration of the variable factors and after free consultation of the internist, the radiologist, and the surgeon.

John T. Murphy, M.D. (Toledo, Ohio): It seems unnecessary again to stress the fact that cancer of the breast is many diseases in one, but too often it is obvious that this is not recognized in the evaluation of results. Because of this it is very difficult for anyone to tell properly what is the true state of affairs. I would make the following statements.

(1) That with our present knowledge radical surgery is the most important thing we have to offer these patients.

(2) That with some exceptions, as for instance the inflammatory type of disease, the clinical extent of the lesion is the most important factor influencing the surgical results.

(3) That radical surgery used indiscreetly may at times do more harm than good.

(4) That radiation therapy plays its most important rôle in inoperable cases, but its injudicious use may also harm the patient.

(5) That radiation in advanced cases may at times be combined with conservative surgery to produce results which can be obtained with neither method alone.

(6) That the radiologist who does not use all the resources of clinical medicine to protect and help his patient is derelict in his duties as a physician.

(7) That radiology is still a young science, and constant efforts to improve technic should be made.

(8) Finally, that many times we are apt as scientists to forget that medicine has two jobs: to

cure where possible, but also, and not the least, to alleviate suffering. In this, radiation has much to offer.

Kenneth Allen, M.D. (Denver, Colo.): I was particularly delighted with Dr. Goin's insistence on the treatment of the patient as well as the cancer. About seven years ago in Cleveland I suggested to a group there convened that an ampule of calcium gluconate intravenously, which I had come upon accidentally, was one very good therapeutic agent for combating radiation sickness. At this time I still feel that calcium gluconate is the best treatment for this condition, though we have tried all the various agents, including vitamin B. Just why calcium gluconate is so effective I don't know, but it does work wonders in many cases. Once in a great while it may make a patient feel a little worse and vomiting may occur when it is given, but that reaction is rare.

With Dr. Goin's statement that patients should be told they have cancer, I cannot altogether agree. In my opinion many should *not* be told, especially early in the treatment, though the family should of course be informed. Some patients will neither sleep nor eat if they know they have cancer, regardless of how tactfully the matter is handled. Some may even destroy themselves.

A. U. Desjardins, M.D. (Rochester, Minn.): There is one thing I should like to say about the point which has just been brought up. Should we, or should we not, tell a patient that he has cancer? This is often a very difficult problem, because temperaments vary so much. Seeing large numbers of patients, as I have had to do for many years, I have tried various ways of solving it. I have watched the reactions to different methods of approach, and certain things have struck me very strongly. The words that are used, and how they are used, may make all the difference in the world. It is not necessary to lie to a patient, but neither is it necessary to tell the whole truth; this is where one has to be careful. As far as our own practice is concerned, the patient is seldom told that he has cancer; we talk instead about "tumors." We never use the word "cancer" as such, because to the average lay person the word has a sinister meaning.

Since most patients come with at least one relative, and sometimes several, we arrange, without the patient's knowledge, to talk to one or all of these together, and they are told the simple truth. A number of physicians, apparently, are not satisfied unless they get the word "cancer" out of their systems; when this is done some patients, unfortunately, become demoralized. In most cases the diagnosis is accurate. Occasionally a case is encountered in which the disease is not carcinoma, but another type of malignant lesion which may not prevent the patient from living for some years, especially with proper treatment. It is seldom wise, therefore, to be too frank with the patients themselves, and especially with those who insist that they be told the truth. Few persons can stand that sort of truth and maintain self control.

I remember one patient whom I saw years ago in Paris. She was an American woman, a descendant of an old, historic family. She weighed 98 pounds, but those 98 pounds contained more fortitude than I have ever found in any 200-pounder. She was brought into the hospital with carcinoma of the rectum, and a preliminary colostomy was done with the idea that a complete resection might possibly be done later. I saw her three times a day, and every evening I made it a practice to spend some time reading to her. She had been very active in various relief organizations in the last World War, and she kept two secretaries busy even while she was in the hospital in bed. One night, about three weeks after her admission, I had started to read as usual but after about five minutes she stopped me and said: "Doctor Desjardins, you have been a very good friend. I am now going to test your friendship. I am not afraid to die; I am willing to die tomorrow if I have to; but, as you know, I am connected with several relief organizations, and I do not want to leave the affairs of these organizations in a bad condition if I have to go. Do you think I should begin to prepare?" Knowing her as I did, I replied: "It might be wise." Thereupon she said: "Thank you, Doctor; go on reading." She continued to keep her two secretaries busy until two days before she died. Persons like this are not to be found every day.

Lowell S. Goin, M.D.: I didn't know that I would precipitate so much discussion, and not wishing to take too much time, I passed rather hastily over this matter of what to tell the patient, merely mentioning that I thought it a good idea not to be too secretive. I do think it is a pretty big question and one that can't be stated so simply as "Shall we tell the patient he has a cancer?" or answered with an unqualified "Yes" or "No." What patient, what circumstances, who is going to do the telling, and in what words, must all be considered. Naturally a certain amount of tact is required, a certain amount of sympathy and understanding of human nature, which you all possess. Then it depends on who the patient is. I would not say to a child, for example, "You have a cancer and are going to die," and I don't see any need for telling an old person, for whom perhaps palliation is all that can be hoped, that he cannot live. I don't think it is necessary to say flatly to a patient that he has a cancer, but on the other hand I think that the patient should know the truth, and for two reasons. The first is that the patient's co-operation is needed. The second is—and this I think I did not make clear—that nothing is so bad as the worry as to whether one has a cancer. People aren't fools. Everyone reads the papers and magazines. Everyone knows that x-rays and radium are used in the treatment of cancer. So when you start giving a long series of x-ray treatments, or using radium, don't think for one moment that the

possibility of cancer doesn't occur to the patient, or that he doesn't think every day, every morning, and in the middle of the night, "My God, have I got a cancer?" It is a lot worse to wonder if you have a cancer than to know that you have one.

In my own experience I have found that when you let the patient know the truth—and mind, I don't mean necessarily in the words, "you have a cancer"—he is pretty depressed for twenty-four to forty-eight hours and then says to himself: "Well, I'm not licked yet—I may feel a lot better and improve."

I think few people have treated more cancer than Dr. James Percy, who is a great surgeon. I have seen him work many times, and his technic is simple and direct. He says: "Well, you have got a cancer—I've got to operate upon you. Maybe I'll kill you, but if I don't the cancer will." And Doctor Percy's patients go to the operating room with the highest morale of any I have ever seen, and I never heard of any of them committing suicide.

John W. Budd, M.D.: The subject of biopsy has been mentioned, and I have been asked to say something about needle biopsy. I should like what I have to say about that subject to be considered as a matter that is entirely individual. It isn't something that is being recommended for anyone else to do. But if one wants to do a biopsy on a tumor of the breast without an open operation, through a very small puncture, and with the minimum of tissue damage, it can be done satisfactorily. A piece of tissue can be removed which is adequate for sectioning. I am not speaking about the removal of material for smears, but an actual cylindrical mass of tissue can be obtained from which satisfactory microscopic sections can be made. In those cases where a program of treatment is chosen that employs irradiation before the operation, and where the doctor in charge of the patient wishes to have the diagnosis definitely established by microscopic examination, it is a very satisfactory procedure.

Treatment of Hemangiomata, with Special Reference to Unsatisfactory Results[1]

WILBUR BAILEY, M.D., and WILLIAM S. KISKADDEN, M.D.

Los Angeles, Calif.

THE GROWTH of vascular birthmarks can be arrested by a large number of methods, not all of which, however, give satisfactory end-results. Since so many of these disfiguring lesions occur in conspicuous places, where they will be visible for a lifetime, the method of treatment finally selected should be the one which substitutes for the hemangioma either normal skin or a scar which deviates as little as possible from this. Most of the unsatisfactory results of treatment are attributable to the selection of a therapeutic agent without regard to its fitness for the particular type or shape of hemangioma which is to be treated.

INCIDENCE

Vascular birthmarks are much more common than is usually supposed. Some authorities believe that one-third of all infants show such marks at birth or during the first year of life. Harwell (3) found 75 angiomata of various sizes and shapes in 1,000 infants examined in a "Better Babies Contest," most of whom were otherwise perfect.

Of even greater importance than the frequency of the lesion is the location. Watson and McCarthy (10) call attention to the fact that, although the head and neck make up less than one-seventh of the body surface, more than half the hemangiomata in their large series of cases were found in these conspicuous locations. There seems, furthermore, to be general agreement in the world literature that the relative frequency of this lesion in females as compared with males is in the order of 2 to 1; some authors place it at 3 to 1. The former ratio is in accord with our experience in 64 cases treated during the last five years in private practice.

CLASSIFICATION

The diagnosis of hemangiomata, with the exception of unusually deep forms, is seldom difficult. From a clinical and pathological standpoint there are three types of vascular birthmarks, but all three types may be present in the same tumor. Since the method of therapy which is selected depends not only upon the size, shape, location, and growth characteristics of the tumor, but also upon the histologic structure, classification is of major importance.

The capillary hemangioma, or "port-wine stain," sometimes referred to as hemangioma simplex, consists of an increased number of venules and capillaries in the deeper layers of the skin, over which the epidermis is thin and velvety. All pediatricians are familiar with the simplest form of hemangioma simplex, which occurs as irregular patches of redness in the region of the eyelids, nose, forehead, or nuchal region in the newborn. These red blotches almost invariably disappear six or eight months after birth and are for this reason unique, for although spontaneous regression may occasionally occur in other forms of hemangioma, it is rare.

The more complex form of the capillary hemangioma is the familiar fiery red or purplish port-wine stain usually found on the head or neck, and frequently in the distribution of the trigeminal nerve.

The fact that the vessels lining these capillary hemangiomata have a well differentiated lining of the adult variety is of considerable importance from a therapeutic standpoint, for it explains the resistance to radium and other forms of therapy. MacCollum (4) in 1935 recommended

[1] Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1–5, 1941.

blistering doses of ultraviolet rays repeated at weekly intervals for four to nine months. More recently in a personal communication he states: "Only those hemangiomata which blanch upon pressure and return to their normal color when the pressure is removed have any hope of responding to the air-cooled ultraviolet lamp treatment. If ultraviolet treatment is given and there is no appreciable change after the first twelve weeks, it is very unlikely that this patient will have any beneficial effect from it." For the most part, authors are in agreement that surgical excision or cosmetic improvement by such pastes as "Cover-mark" is the most satisfactory therapy.

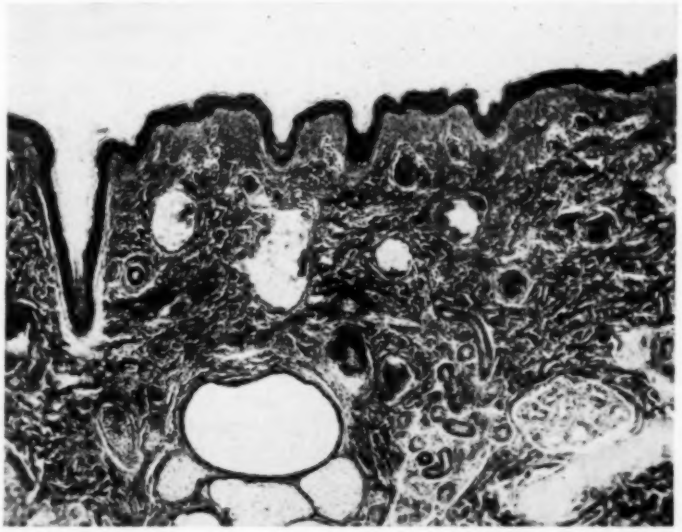


Fig. 1. Section of hemangioma simplex or port-wine stain. The adult type of endothelium which lines the blood vessels is, like all adult tissues, not particularly sensitive to radiation. (Courtesy of Dr. Forrest O. Young.)

Unsatisfactory results in the treatment of capillary hemangiomata may be expected from radium or x-rays, for the advanced differentiation of the blood-vessel endothelium in these lesions in adults sets them apart from other forms of hemangiomata, in which less endothelial differentiation is present. Unusually heavy doses of x-rays or radium are required to effect destruction of the well differentiated lining in these blood vessels (Fig. 1). Such heavy irradiation, or even prolonged treatment with carbon dioxide snow, may cause the port-wine stain to become irregularly faded or pigmented, usually producing, as the final result, a geographical appearance which is considerably more disfiguring than the original lesion. With x-rays or radium the same danger is present as in their use for removing superfluous hair. To be effective the dose must be sufficiently large to produce skin atrophy. As a result, the sebaceous glands are destroyed, and covering cosmetics will no longer adhere satisfactorily to the skin. The possibility of radiation epithelioma is, of course, also present as a result of repeated overdosage.

The so-called "strawberry mark" constitutes the second division in classification of the hemangiomata. These hemangiomata involve the true skin and submucosa. Young's designation, "hypertrophic endothelial hemangioma," for this group is suitable, for it gives a key to the underlying pathological histology (11). Masses of endothelial cells are found displacing the skin and subcutaneous tissues. The proliferative growth of these cells is so

great that many of the blood vessel walls are compressed as the tumor grows and appear only as fissures in the histologic section.

This lesion with its bright red, irregular surface, elevated above the normal skin, is clinically the most familiar of the three types. Frequently growth is rapid, and in two cases in our series, in twins, the rapidity of growth appeared to be almost malignant in nature. Typical metastases have been reported in the literature.

The masses of endothelial cells which are demonstrable histologically are of therapeutic and prognostic importance, for such undifferentiated tumors would be expected to be highly radiosensitive, and this is usually the case. Tumors in which the tendency to overgrowth is so great that vessel collapse occurs might be expected occasionally to undergo thrombosis and necrosis, with concomitant infection, either spontaneously or with minor amounts of treatment. Such complications, though infrequent, occurred once in our series.

"Cavernous hemangioma" constitutes the third group in classification. These deep tumors may be covered by entirely normal skin, but can usually be distinguished through the latter as a purplish swelling. The swelling increases when the young patient cries, or when an extremity involved by the lesion is lowered. Conversely, such a tumor can usually be decreased in size by pressure. These deep tumors may occur not only in the subcutaneous tissues and mucosa, but also in muscle and in the viscera. The histologic picture is of interest, for a consideration of the structure and the location of the tumor will indicate what type of therapy might be most satisfactory.

A typical cavernous hemangioma (Fig. 2) is made up of large blood spaces which are lined by endothelium and separated by large connective-tissue septa. From a therapeutic standpoint it will at once become evident that even though the blood vessels are collapsed, a tumor consisting of fibrous tissue may be left behind. Actually, although such undesirable end-results are reported, we have not met them in true hemangiomata. In those lesions in which previous biopsy has shown a marked fibrous component, surgical excision has in our experience proved preferable to radiation.

TREATMENT

The treatment depends to a great extent upon the classification of the tumor. Capillary hemangiomata or port-wine stains have already been discussed, excision being the therapy of preference and ultraviolet radiation or cosmetic pastes being desirable in some cases. The "hypertrophic endothelial" and "cavernous" types of hemangiomata can be treated in a variety of ways. Surgical excision may, of course, be used for any type of hemangioma. Frequently, however, these lesions are on the face or are so large or are located so close to important vessels or nerves (especially the seventh) that excision is not practicable. After other methods have been used, surgery in some cases may be appropriate for excision of scar tissue.

Destructive methods are many in number, and are aimed chiefly at sclerosing the lining of the vessels. For this purpose fulguration with cautery, insertion of hot platinum needles, pressure to produce ulceration, scarification, and even vaccination have been used. Injection with a great number of different substances, electrocoagulation, freezing with carbon dioxide snow, and x-ray and radium therapy are all in use at the present time.

Since there are so many methods, and since all of them will produce a more or less successful obliteration of the hemangioma, it is important that one be selected, with a view to the particular type and the extent of the lesion, that will produce an end-result most closely resembling normal skin. Most of the unsatisfactory or poor results which we have seen have been the result of two things:

1. Watchful waiting on the part of the patient or, more rarely, the physician, to see whether spontaneous regression might occur. We have seen only a single case in

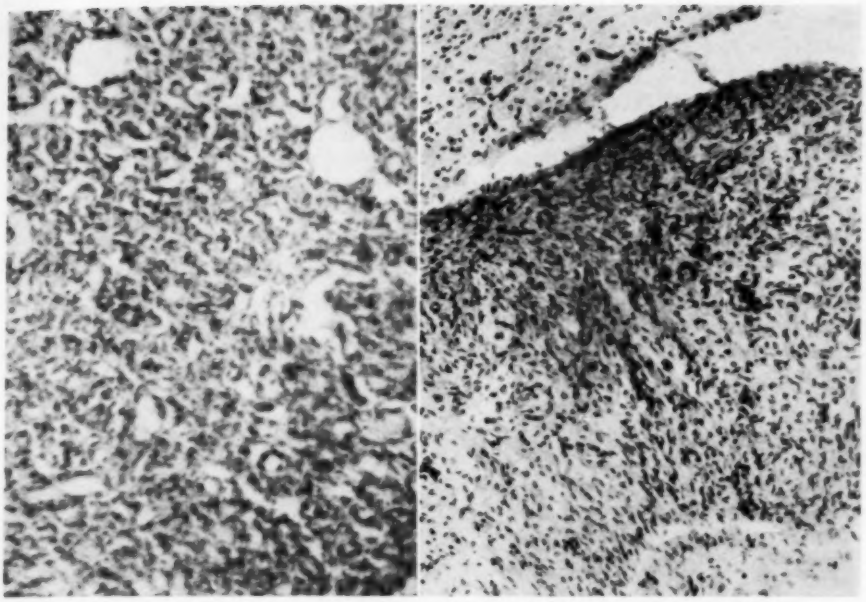


Fig. 2. (left). Section of cavernous hemangioma. The hypertrophic type of endothelium lining the blood vessels makes these lesions sensitive to properly placed radiation.
Fig. 3 (right). Section of fibrohemangioma. Hemangiomata with large components of fibrous tissue are best treated by excision.

which such regression is occurring, but for this one there are 19 in our series in which a small lesion doubled or trebled its invasive growth during the time lost in such a vain period of waiting.

2. The selection of the wrong therapeutic agent. Such wrong selections are usually made because due concern is not given to the depth, extent, and particular type of lesion. Carbon dioxide snow or the beta rays of radium are not suitable and are even dangerous in the treatment of deep hemangiomata; yet they are all too frequently still used in such cases.

The more common methods will be reviewed with particular attention to their applicability.

Surgical Treatment: Some observers, having experienced disappointing failures with other methods, have advocated the surgical removal of all types of angiomata. We believe this point of view is too radical, but feel that selected cases of many types lend themselves to easy surgical excision. The decision depends on the location of the tumor and the probable cosmetic effect. Certainly small superficial lesions about the eyelids can usually be removed most safely by excision. With the hyperplastic endothelial type of hemangioma, which tends to cover a large area, the decision must be made as to whether the possible patchy appearance of a graft is more to be desired than the results obtained with radium.

If the lesion is elevated, it is our belief that radon seeds should first be employed. Later, if necessary, the skin result can be improved by grafting. With the cavernous type of hemangioma, also, radiation frequently solves the problem, but when there is a large fibrous tissue component in the tumor, a better result can usually be obtained by surgical excision than by any of the other forms of treatment (Fig. 3). Bleeding is excessive at times but usually can be controlled by digital pressure. If, because of inaccessibility, the entire tumor cannot be excised, particularly in the case of involvement of the mucous

membrane of the lip and cheek, plicating and mattress sutures placed through and around the lesion will usually cause thrombosis and obliteration of the spaces and veins.

Electrocoagulation: Electrocoagulation is recommended by Figi (2) as of value in the cavernous hemangiomata of adults. Because these lesions in adults are well differentiated and respond poorly to radium, he recommends the use of a long steel wire electrode, which is thrust deeply into the tumor, after which the current is turned on. The chief difficulty with this method is in gauging the intensity and extent of the coagulating process. Should the amount of cooking be too great, sloughs are likely to produce unsatisfactory results.

Sclerosing Solutions: The use of sclerosing solutions dates back almost 100 years, when Pravez (7), prior to 1845, injected ferric chloride for coagulation of blood in aneurysms and hemangiomata. Since that time acetate of peroxide of iron, hot water, alcohol, quinine hydrochloride, and urethane, as well as innumerable other solutions, have been used.

Peyton and Leven (6) and Watson and McCarthy (10) recommend sodium morrhuate in 5 per cent solution as advantageous, because, unlike quinine and urethane and other sclerosing agents, it does not cause painful necrosis when injected into normal tissues. With a long hypodermic needle they inject 0.25 to 3.0 c.c. into the lesion. If blood can be withdrawn into the syringe, they inject the entire amount at this site. Otherwise the solution is injected diffusely throughout the lesion. Pressure is maintained for five minutes. Injections are repeated at intervals of two to five weeks.

Other investigators have reported encouraging results from the use of sclerosing solutions. Our experience has been somewhat limited and on the whole disappointing (Fig. 4).

Fig. 4. Cavernous hemangioma, 6 × 3 cm., in a two-year-old girl. This was treated by repeated injections of boiling water, without result (left), but disappeared following interstitial radon seed therapy (right).

Unsatisfactory results from sclerosing solutions may occur because of sensitivity to the solution, in which case a generalized reaction may develop. Marked swelling usually ensues, and the possibility of infection and sloughs is always present. In hemangiomata in which the blood is circulating rapidly, the sclerosing substance may be carried away before it has a chance to act. Nevertheless, this method seems the best to use in the treatment of cavernous hemangiomata in adults, if surgical excision is not possible.

Carbon Dioxide Snow: Carbon dioxide snow was introduced as a freezing agent by Pusey in 1907, and still remains popular with dermatologists. Repeated applications for seven to ten seconds on small superficial hemangiomata of the hyper-

trophic endothelial type may be satisfactory. When too large a dose is used, blistering, and later scar formation, may occur as unsatisfactory results.

The most serious and most common error in the use of carbon dioxide snow is the attempted treatment of deep strawberry marks or even cavernous hemangiomata. Under these circumstances the overlying skin may be blanched or considerably damaged, while the underlying tumor continues its destructive spread unchecked by the surface applications (Fig. 5).

Fig. 5. Hypertrophic endothelial hemangioma in a boy ten months old. Repeated applications of carbon dioxide snow merely blanched the surface of the lesion (left). Implantation of gold radon seeds destroyed the cavernous portion, as shown in the photograph (right) taken at twenty-two months.

Radiation Therapy: Radiation, especially in the form of radium, is a most useful agent in the treatment of the hypertrophic endothelial or cavernous types of hemangiomata, if the proper method of application be employed. Since the sensitivity of vascular birthmarks to radium decreases inversely with the age of the patient, early treatment must be urged.

In the use of radiation it must be remembered that these vascular tumors are mesothelial rather than epithelial in origin, and that radiation therapy must, therefore, be employed in such a way as to spare the true skin as much as possible if permanent scarring is to be avoided. Also, it must be borne in mind that overdosage may not only produce scarring and atrophy, but may stop the growth of bone or sensitive tissues in the neighborhood of the vascular tumor.

Many hemangiomata are exceptionally sensitive to radiation, and a trial of x-ray therapy is, therefore, sometimes warranted over very large lesions. Although Spencer (9) and others describe treatments of 200 r given with 200 kv.p. and a filter of 0.5 mm. copper, at a distance of 20 cm., repeated at intervals of two or three months, as unfailing, this has not been our experience. We have caused many large tumors to shrink by such dosage and have seen some of the smaller ones disappear completely, but in general the results wtih x-rays have been less satisfactory than those obtained with radium.

In the treatment of small children x-rays have not proved satisfactory for several reasons. Though our equipment enables us to deliver a 200 r dose in a fraction of a minute, it is often difficult to keep a small child in proper apposition to the apparatus for even a short time. Furthermore, our results have not been uniform and have sometimes been disappointing even when the dosage was raised to a point where the surrounding epiphyses, bones, and other soft-tissue structures were getting amounts large enough to be a possible menace to normal growth.

Unsatisfactory results in the skin may be precipitated by small doses too often re-

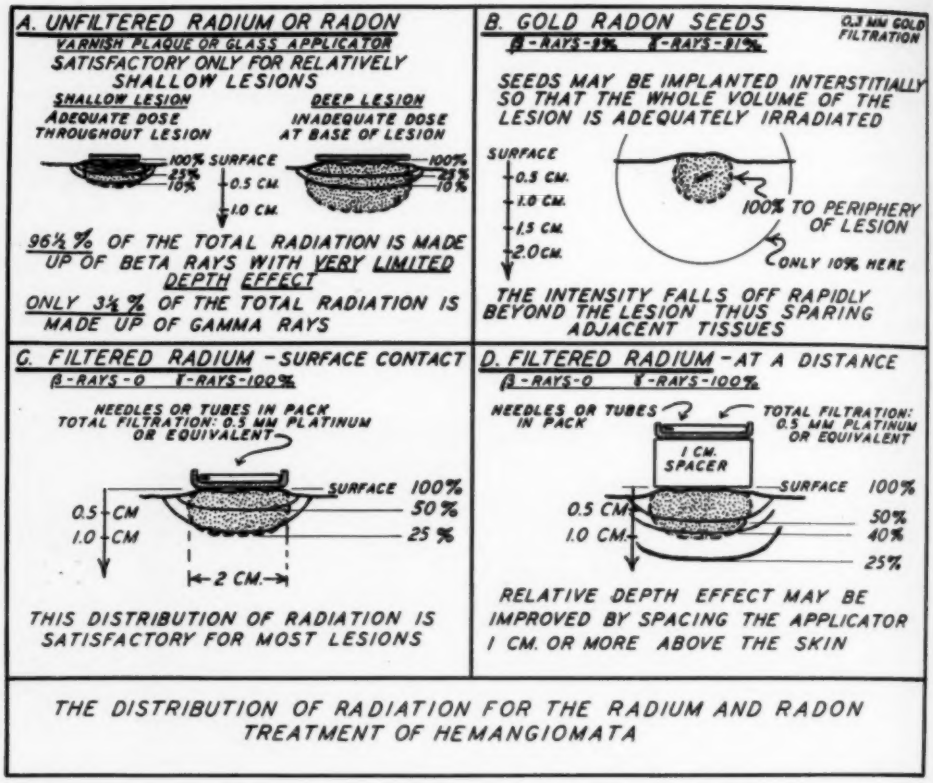

A. UNFILTERED RADIUM OR RADON
VARNISH PLAQUE OR GLASS APPLICATOR
SATISFACTORY ONLY FOR RELATIVELY SHALLOW LESIONS
SHALLOW LESION
ADEQUATE DOSE THROUGHOUT LESION
DEEP LESION
INADEQUATE DOSE AT BASE OF LESION
100% SURFACE
25%
10%
0.5 CM.
1.0 CM.
96½% OF THE TOTAL RADIATION IS MADE UP OF BETA RAYS WITH VERY LIMITED DEPTH EFFECT
ONLY 3½% OF THE TOTAL RADIATION IS MADE UP OF GAMMA RAYS
B. GOLD RADON SEEDS
0.3 MM GOLD FILTRATION
β-RAYS-19% γ-RAYS-81%
SEEDS MAY BE IMPLANTED INTERSTITIALLY SO THAT THE WHOLE VOLUME OF THE LESION IS ADEQUATELY IRRADIATED
SURFACE
0.5 CM.
1.0 CM.
1.5 CM.
2.0 CM.
100% TO PERIPHERY OF LESION
ONLY 10% HERE
THE INTENSITY FALLS OFF RAPIDLY BEYOND THE LESION THUS SPARING ADJACENT TISSUES
C. FILTERED RADIUM - SURFACE CONTACT
β-RAYS-0 γ-RAYS-100%
NEEDLES OR TUBES IN PACK
TOTAL FILTRATION: 0.5 MM PLATINUM OR EQUIVALENT
SURFACE 100%
0.5 CM 50%
1.0 CM 25%
2 CM.
THIS DISTRIBUTION OF RADIATION IS SATISFACTORY FOR MOST LESIONS
D. FILTERED RADIUM - AT A DISTANCE
β-RAYS-0 γ-RAYS-100%
NEEDLES OR TUBES IN PACK
TOTAL FILTRATION: 0.5 MM PLATINUM OR EQUIVALENT
1 CM. SPACER
SURFACE 100%
0.5 CM 50%
1.0 CM 40%
25%
RELATIVE DEPTH EFFECT MAY BE IMPROVED BY SPACING THE APPLICATOR 1 CM. OR MORE ABOVE THE SKIN
THE DISTRIBUTION OF RADIATION FOR THE RADIUM AND RADON TREATMENT OF HEMANGIOMATA

Fig. 6. Diagrams indicating marked contrast in depth dosage with different technics. Note especially the shallow penetration obtained from beta rays present in unfiltered applicators.

peated. Two cases treated elsewhere many years previously showed marked skin atrophy and malignant degeneration which required excision and corrective surgery. For these reasons we are not satisfied with x-ray treatment alone for routine use in hemangioma therapy.

The beta rays of radium, such as are given off by radium plaques or radon in glass applicators, may be useful for small hemangiomata confined to the epidermal layers of the skin. The danger of using such agents for deeper lesions is readily appreciated by a comparison of the isodose curves in Figure 6A. As can be seen from this diagram, the beta radiation, which constitutes 96.5 per cent of the unfiltered radium output, is absorbed almost entirely by the superficial tissues and thus has a very strong caustic effect on the outer layers of the skin. It is a dangerous mistake, therefore, to use unfiltered radium plaques for any but the most superficial lesions. If such beta ray therapy is employed for deeper lesions, the skin may be severely damaged, while the deeper portion of the hemangioma receives relatively little radiation (Fig. 7).

The gamma rays of radium, as provided by properly filtered radium packs, are most useful, and frequently even deep hemangiomata disappear with such treatment. Although with radium pack therapy the dose to the skin must necessarily be higher than the dose to the tumor, the distribution is still satisfactory. Many hemangiomata are so sensitive that one or two doses of 700 to 1,000 gamma roentgens (8) will precipitate disappearance of the vascular tumor without damaging the skin.

We favor the use of filtered radium packs at distances of 3 mm. for superficial lesions, and 1 to 3 cm. for deeper lesions. The radium must be arranged in a geometrical design so that all portions of the tumor are irradiated as evenly as possible. To the filter of 0.5 mm. of platinum (which stops all of the beta radiation), are added 1 mm. of silver and 0.5 mm. of brass as secondary filters. The total filtration effect, therefore, is that of 1 mm. of platinum with 0.5 mm. of brass as a secondary beta ray filter.

of 0.2 mm. of gold and a strength of 0.25 to 0.5 mc. can be planted in an appropriate geometrical arrangement so that there is one in every cubic centimeter of angioma tissue (1). The radiation distribution is such that the skin gets less dosage than the lesion, if the seeds are planted sufficiently deeply (Fig. 6B).

The method of implantation is relatively simple and can be carried out as an office procedure. Frequently a single implantation of radon seeds will be sufficient to cause the angioma to disappear—a

Fig. 7. Hypertrophic endothelial and cavernous hemangioma in a one-year-old boy. The response to repeated application of the radium plaque, without filtration, was unsatisfactory (left). Application of filtered radium and radon seeds produced a favorable response, as shown in the photograph taken at the age of two years (right).

We have not seen any undesirable results from radium packs with proper filtration. Often the skin returns entirely to normal, but when it does not, the pliable pinkish-white scar which usually occurs instead is not unsightly. Treatments, as recommended by Newcomet (5), should be spaced when possible at intervals of two or three months, but the patient should be observed in the interval, for hemangiomata have been encountered, of both the endothelial hyperplastic and cavernous types, which have almost doubled in size in two weeks, and which have required considerably more vigorous therapy.

Gold radon seeds with a wall thickness

matter of considerable importance to patients who have come from a distance. These tiny gold radon seeds are not removed from the tissues, but we have seen no unsatisfactory results on this account except when too many seeds were planted or the implantations were too close to the surface.

Since radon seed implantation is a relatively simple process, which frequently requires only one visit, it seems to us the method of choice in the deeper hemangiomata, although we generally use heavily filtered radium packs in a preliminary attempt to determine whether the lesion is unusually radiosensitive in nature.

CONCLUSIONS

1. Prompt treatment of hemangiomata is indicated, because most types are more sensitive to treatment in the very young. Although spontaneous regression does occur in rare instances, much valuable time is often lost in the vain hope that this may ensue, while actually invasive growth is greatly increasing.

2. Unsatisfactory results in treatment are most frequently caused by the selection of the wrong agent for the particular type of hemangioma.

3. The hypertrophic endothelial form of hemangioma, known as the strawberry mark, and the even deeper type of cavernous hemangioma, respond well to irradiation. Although x-ray therapy is often satisfactory, the gamma rays of radium in the form of well filtered radium packs have in our experience given more uniform results. The implantation of weak gold-filtered radon seeds permits a very favorable distribution of the radiant energy. For this reason, and because frequent repetition is not required as with other methods, radon seed implantation is often the therapy of choice.

2009 Wilshire Boulevard, Los Angeles, Calif.

BIBLIOGRAPHY

1. BROWN, JAMES B., AND BYARS, LOUIS T.: Interstitial Radiation Treatment of Hemangiomata. Am. J. Surg. **39:** 452–457, February 1938.

2. FIGI, FREDERICK A.: Treatment of Angioma of Face. Arch. Otolaryng. **24:** 271–281, September 1936.

3. HARWELL, W. R.: Radium Treatment of Hemangiomata. New Orleans M. & S. J. **92:** 576–580, April 1940.

4. MACCOLLUM, DONALD W.: Treatment of Hemangiomas. Am. J. Surg. **29:** 32–35, July 1935.

5. NEWCOMET, WILLIAM S.: Treatment of Nevi: Review of Cases Treated during the Last Fifteen Years, with Analysis of End-Results. Radiology **22:** 684–693, June 1934.

6. PEYTON, W. T., AND LEVEN, N. L.: Hemangioma and Its Treatment. Surgery **3:** 702–718, May 1938.

7. PRAVEZ: Quoted by Peyton.

8. Report of the Research and Standardization Committee of the American Radium Society: Am. J. Roentgenol. **43:** 118–125, January 1940.

9. SPENCER, JACK: Radiation Treatment of Hemangioma. Am. J. Roentgenol. **46:** 220–223, August 1941.

10. WATSON, WILLIAM L., AND MCCARTHY, WILLIAM D.: Blood and Lymph Vessel Tumors: Report of 1056 Cases. Surg., Gynec. & Obst. **71:** 569–588, November 1940.

11. YOUNG, FORREST: Vascular Birthmarks: Diagnosis and Treatment. J. Pediat. **14:** 671–683, May 1939.

DISCUSSION

Rollin Stevens, M.D. (Detroit, Mich.): The authors of this paper have presented their subject in a very scientific way and this I believe is just the sort of presentation needed in the study of hemangiomata. So many methods are used that are not only useless but injurious. I would, however, take exception to the statement condemning the use of radium in certain hemangiomata. During the past thirty-odd years we have had some perfect results with this method. It is well to warn physicians, however, to be careful about using radiation in these cases. Radium is no doubt a dangerous agent, but I cannot reconcile the effects of the small doses of radiation that I have given to hemangiomata of the strawberry type with telangiectatic atrophy, etc. I have treated not only single lesions of this kind but cases in which a large part of the face was involved. In one case, in a child of four months, the entire face and neck were covered with large strawberry lesions from 1 to 2 cm. in diameter, standing out like blood on a piece of beef—a horrible sight. I applied 2 mg. of radium with a French varnish plaque, one-quarter strength, 2.5 cm. square, with a filtration of about ten pieces of ordinary writing paper, for eight hours. Eight hours with that plaque does not produce an erythema (about ten or twelve hours are required), and yet, with one series of treatments covering each lesion, all finally cleared up. I didn't see the patient again until about twelve years later, when she came into the office. She was a pretty child; her face was perfectly smooth, and there was no sign whatever of any of the lesions.

I have many times seen single lesions react in this same way to very small doses. The reason, I think, lies in an effect upon the base of the lesion that we do not yet understand. It is not a matter of selecting an agent that is going to destroy endothelial cells directly, because so small a dose could not destroy these cells. In fact, they are generally pretty resistant to radiation, and yet after very small doses of radium (we have cut out some of the slower kinds of radiation and allowed the faster radiation to go through) there has been enough to change the tumor bed so that the whole thing has disappeared. Whether that is sufficient to produce a fibrosis that chokes off the nourishment of the cells so that they finally die, we do not know.

The only criticism I have to make of this paper is that too much stress has, in my opinion, been laid on the direct action of radiation upon the endothelial cells of hemangiomata, overlooking perhaps the effect these radiations may have on the stroma in order to bring about the results that we see.

Dr. Bailey (*closing*): We agree with Dr. Stevens that beta ray therapy is often very satisfactory in shallow lesions. One of the reasons we wrote this paper, however, was because Dr. Kiskadden, who is a plastic surgeon, was so discouraged by the results he had seen from radium plaque beta ray therapy. Such treatment, usually administered by non-radiologists, was found in numerous cases to have resulted in severe skin damage. Of even more importance, the deeper portions of cavernous tumors were frequently found to have continued their growth during the period of treatment. In other words, in such instances beta radiation had been used without regard to the all-important question of depth dose.

Small doses of any kind of radiation frequently accomplish remarkable results. For this reason it is our practice to use radium packs in the beginning, and to consider the implantation of radon seeds only if results are not forthcoming by radium pack therapy, or if the patient lives far away and can be present for only a single visit.

Methods Used and Results Obtained in Treatment of Widespread Metastases Secondary to Mammary Cancer[1]

WILLIAM E. HOWES, M.D., and LOUIS BERNSTEIN, M.D.

Brooklyn, New York

PHYSICIANS have long recognized the hopeless prognosis of mammary carcinoma which has metastasized widely. This point of view has, indeed, become so firmly entrenched in the minds of some of our colleagues that such patients are too often treated with sedatives and recommended for custodial care. It is our contention that often much can be done in the way of alleviation through direct irradiation of the involved parts. The improvement following such treatment may be exceptional, with the more fortunate patients restored to their usual activities for a period of years. Pfahler (1) has stated that radiation therapy has prolonged life in certain instances from one to four years.

Most of the literature on the subject deals with treatment of skeletal metastases and it is, of course, the response of these bone lesions to irradiation that is most striking. Lee and Herendeen (2) in 1924 reviewed 54 cases of inoperable breast cancer, noting the symptomatic relief following irradiation of bone metastases and emphasizing the dangers of overirradiation to the lung. Leddy (3) has summarized the literature up to 1930. He states that Freund (4), in 1907, was the first to report clinical improvement following treatment of a probable metastasis in the pelvis. Freund's presentation, however, received little attention, inasmuch as Matthews (5) as late as 1915 could find no record in the literature of radiation therapy for secondary malignant growths of bone. Most of the earlier reports which spoke of the favorable radiation effects cited only a few isolated cases.

In 1936 Leddy and Desjardins (6) reviewed 573 cases of recurrent and metastatic carcinoma of the breast seen at the Mayo Clinic between 1924 and 1933. Of 268 patients who received what these authors regarded as adequate irradiation, 106 improved, while 26 obtained an "unfavorable or uncertain result." It was concluded that metastatic lesions to lung or liver respond poorly to treatment and that osseous metastases represent the more favorable field for treatment.

The treatment of the patient suffering from widespread metastatic mammary carcinoma includes measures for relief of pain and palliative procedures.

Relief of Pain: Under this heading opium and its derivatives must be placed first. With prolonged use, however, larger and larger doses must be given until the attending physician is faced by a double clinical entity, namely, carcinoma and morphinism. Besides opiates the following sedatives have been used, with greater or lesser effectiveness: bromides, salicylates, barbiturates, chloral hydrate, and paraldehyde. More recently the vitamins, particularly A and B, in large doses have been found to be of value. Cobra venom has also been tried and in certain instances shown to have an analgesic effect. Alcohol block, section of the sensory root, and chordotomy have all been recommended and are of limited but of specific value.

Orthopedic appliances must be considered as having a definite effect in relieving pain. A plaster spica may prevent kyphosis and a resultant transverse myelitis. In this connection we would like to emphasize the superiority of the old-fashioned whale-bone corset for support in the presence of metastases in the lower dorsal or lumbar spine and pelvis. Such a corset can be easily adjusted and removed without the disadvantages of surgical ap-

[1] Read before the Radiological Society of North America at the Twenty-seventh Annual Meeting, San Francisco, Calif., Dec. 1-5, 1941.

plication. The Thomas splint and other orthopedic measures may be needed when the disease has gone on to fracture of any of the long bones. A hard mattress should be used or a fracture bed procured.

The influence of religious euphoric states and other types of hypnosis must be included in this classification. The modern man of medicine must not lose sight of the ability of the human mind under certain conditions to transcend material conditions. The authors have been impressed by the change in attitude and appearance of certain patients after their transfer to some denominational hospital for the care of incurables.

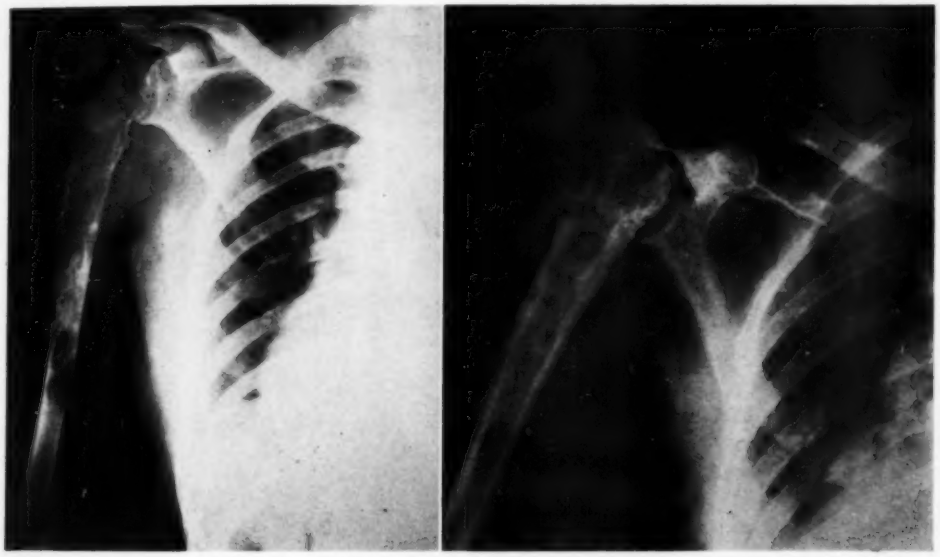


Fig. 1. Metastatic carcinoma of humerus with pathological fracture (Case H. G.), before and after treatment by irradiation.

Palliation: The Greeks appreciated the value of the actual cautery in the treatment of carcinoma. With the development of asepsis and surgery, the scalpel came to play a prominent part. The addition of the radio knife and the electrocautery has given wider scope to the surgical attack, while the discovery of radium and its application in the form of permanent or temporary implants have augmented the surgeon's armamentarium. All of these procedures, however, are dependent on the accessibility of the lesion.

Colloidal gold and lead have been administered to no avail. More recently, colchicine and even Coley's toxins have been tried and found of questionable value.

Hyperthermia must be mentioned but only in conjunction with x-ray therapy. Since the work of Smith and Fay (7) cryotherapy has been tried, but Sano and Smith (8) state that at least two hundred forty hours of generalized refrigeration are needed to induce any significant regression of metastases. Vaughn (9), in a preliminary report on six patients, concludes that the method is too hazardous and is not justifiable.

Indirect irradiation, to the ovary, may perhaps be said to date back to the results claimed for oophorectomy by Schinzinger (10), 1889, and Beatson (11), 1896. According to Dresser (12), Beatson claimed "shrinkage of the primary tumor, reduction or disappearance of skin recurrences, and regression of glandular metastases." Foveau de Courmelles (13) was apparently the first to employ radiation in the castra-

Fig. 2. Metastatic carcinoma of pelvis (Case F. M.) with bone regeneration after irradiation, as shown in the lower illustration.

tion of women suffering from mammary carcinoma. Ahlbom (14) studied 163 cases treated by indirect and a combination of indirect and direct radiation, and concluded that there is no real value in radiation castration. Dresser stated that, though the effect was favorable in patients below the menstrual age, irradiation of the ovaries in women past the menopause was valueless. Daland (15), in a personal communication (16), described improvement and a five-and-one-half-year survival in a single case. He stated that he has seen "marked regeneration of the bone in about one out of three patients below the menopause who have been sterilized." Further studies of the results produced by irradiation of the ovaries and other glands of internal secretion, as the pituitary, thyroid, and adrenal, are indicated.

No matter how striking the improvement in metastases following irradiation of the ovaries, the results of x-ray therapy directly to the affected part are even more specific. Not only is there a certain psychological change in the patient's attitude with relief of pain, but in most instances improvement is actual and demonstrable.

Skin and bone metastases respond most strikingly. Skin metastases can be destroyed by single or multiple treatments. Bone metastases show evidence of calcium deposition and bone regeneration after this type of therapy (Figs. 1 and 2).

Symptoms due to metastases in lung, pleura, and even brain have also been

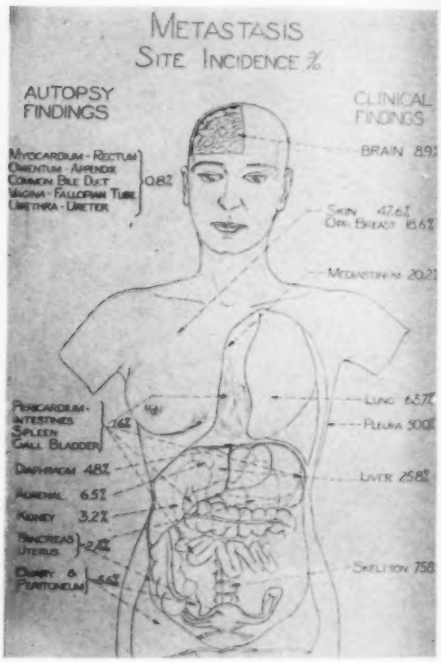


Fig. 3. Sites of metastases from carcinoma of breast: clinical and autopsy findings.

temporarily alleviated. When the liver is involved, radiation has proved ineffectual. Treatment appears to accentuate the preexisting symptoms of nausea and vomiting. Jaundice secondary to metastases has not cleared following radiation therapy, in our experience.

AUTHORS' SERIES

The striking improvement following irradiation of several bedridden women who

had widespread metastases prompted this survey. All cases with distant metastases—that is, beyond the axilla and supraclavicular fossa—admitted to the Hospital or Clinic of the Brooklyn Cancer Institute between October 1936 and December 1939 were studied. This afforded a minimal two-year follow-up in each case and presented an opportunity to judge the effectiveness of treatment.

Records of 124 women suffering from distant metastases were reviewed. The average age was 50.2 years; the youngest patient in the series was twenty-eight, the oldest seventy-six. Forty-five of the number were forty-five years of age or younger. Fifteen of this younger group received pelvic irradiation in conjunction with direct irradiation to the metastatic lesions. We are, therefore, unable to evaluate the effects of x-ray sterilization, though in some cases metastases improved which had not received direct radiation.

TABLE I: AGE INCIDENCE IN 124 CASES

20–29	2 (1.6%)
30–39	22 (17.7%)
40–49	37 (29.8%)
50–59	35 (28.2%)
60–69	21 (17.0%)
70–79	7 (5.7%)

Eighty-three of the entire group were considered to have received adequate irradiation to at least some of the metastatic lesions; those who received only 600 r or less to one or two locations were classified in another group as inadequately treated.

The location of the metastases is shown in Figure 3.

TABLE II: AVERAGE LIFE DURATION AFTER ONSET OF METASTASES

Entire group	14.8 months
Adequately treated group	19.6 months
Inadequately treated group	5.1 months

Of the 83 patients that were classified as having received adequate treatment, 11 are still alive, a salvage of 13.3 per cent. Meyerding, Carman, and Garvin (17) record the average life duration in their series as less than six months without treatment.

Table III lists the living patients and the time interval of their survival following demonstration of distant metastases. Life duration and average life duration after onset of metastases for all patients are shown in Table II and Figure 4.

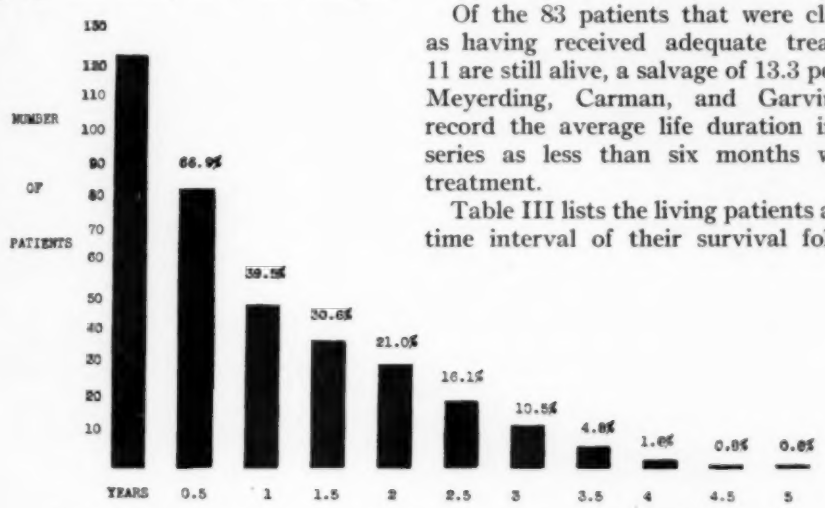


Fig. 4. Life duration after appearance of metastases from carcinoma of the breast.

TABLE III: LIFE DURATION, IN MONTHS, AFTER ADMISSION WITH METASTASES, FOR PATIENTS STILL LIVING

1 (K. Y.)	53	Custodial care
2 (S. S.)	41	
3 (H. G.)	38	
4 (J. M.)	44	Ambulatory and comfortable
5 (H. S.)	38	
6 (M. N.)	35	
7 (J. K.)	35	
8 (J. F.)	35	
9 (A. M.)	25	
10 (I. J.)	23	
11 (F. G.)	22	

DIFFERENTIAL DIAGNOSIS

As has been stated, bone is one of the most common sites of metastasis from

Fig. 5. Mediastinal metastases resulting in partial esophageal obstruction.

mammary carcinoma. Pain is an early symptom. It is usually well localized and is made worse on motion or direct pressure. Usually the bone lesions are visible on the x-ray film as clean-cut or lacy-edged multiple osteolytic foci. When the vertebral bodies are attacked, early collapse takes place. The absence of the laminae or pedicles on the film can easily be overlooked. Radicular pain secondary to so-called pressure on the sensory nerve roots is typical of spinal involvement. If the dorsal segments are involved the pain is apt to be of the intercostal type; when the lower lumbar or sacral spine is diseased, the pain can be referred down the course of the sciatic nerve. This referred pain is often relieved by one or two treatments to the involved spinal segment, in spite of collapse or other permanent bone deformity.

Skin metastases are self-evident; biopsy will confirm any questionable lesion. Scattered skin metastases usually indicate visceral spread as well.

Pleural effusion even years after removal of a breast for carcinoma is usually due to pleural metastases. History, temperature, pulse, respiration, and cell count tend to differentiate this from an inflammatory pleuritis. Centrifuging the withdrawn fluid and blocking the cell sediment have at times confirmed the clinical diagnosis.

Mediastinal involvement is suggested by the symptoms and clinical findings and is usually confirmed by roentgen studies. Paralysis of one of the recurrent laryngeal or phrenic nerves is among the most common symptoms, as is also evidence of partial circulatory or respiratory block. A mediastinal mass may also encroach upon the esophagus and produce dysphagia. A case with this type of complication (Fig. 5), proved by biopsy through the esophagus, has been treated. Moderate symptomatic relief was obtained following x-ray therapy.

Fig. 6. Treatment areas and angulation of x-ray tube for irradiation of dorsal vertebrae.

Pulmonary metastases without coincident pleural effusion are easily visualized on the x-ray film. Needle puncture has confirmed large pulmonary as well as mediastinal metastases. One of the most difficult differential diagnoses to make is that between certain types of lymphatic spread of carcinoma into the lung and pleura and pleural pulmonitis secondary to irradiation. The patient with carcinoma becomes progressively worse, while the one with pleural pulmonitis may suffer for years with little change in the general condition.

Metastases to the brain may be suspected from involvement of any of the cranial or other motor nerves, headaches, choked disc, or a change in personality. A retiring young woman, for example, changed over night into an hilarious moron. Explosive laughter was her only reaction to outside phenomena. At autopsy, a metastasis, the size of a golf ball, was discovered in the frontal lobe.

Intra-abdominal metastases, except for those located in the liver and associated with ascites, are difficult to diagnose until the mass is palpable through the abdominal wall. The liver is not always palpable, nor is jaundice often present. Such patients have no appetite, complain of nausea, and vomit frequently. Their rapid downhill course makes the assumption of liver metastases a probability.

Retroperitoneal metastases are rare. When they occur, they may obstruct a ureter.

TREATMENT

A single five-year cure in the presence of widespread metastases, as reported by Clarkson and Barker (18), should stimulate all radiologists to treat such cases. The method used by these authors, of moving the table so that the patient actually received radiation to the entire body, is ingenious but unfortunately makes it impossible to compute how much radiation any one part received.

The following summary represents the methods of treatment used at the Brooklyn Cancer Institute in the group of cases reviewed in this survey:

Bone Metastases: The spine is one of the most frequent sites of metastatic deposits from breast carcinoma. Pathology is seldom limited to one vertebral segment. Even though the x-ray film does not disclose more than a solitary lesion, a considerable segment of spine is included in the treatment zone. The spine is always cross-fired through two posterior oblique ports, 7 × 10 to 7 × 15 cm. (Figs. 6 and 7), except in the cervical area. Maximum filtration and voltage are used, namely: kv. 200, H.V.L. 1.8 mm. Cu, T.S.D. 50 cm.; 200 r in air are delivered to each of two areas daily for a total of 2,000 to 2,600 r in air per port. The tumor dose will vary anywhere from 30 to 60 per cent of the skin dose, depending upon the part and the type of patient. In the cervical region, lateral ports, approximately 6 × 8 cm. in size, are chosen. The depth dose can be augmented by employment of a third, posterior field.

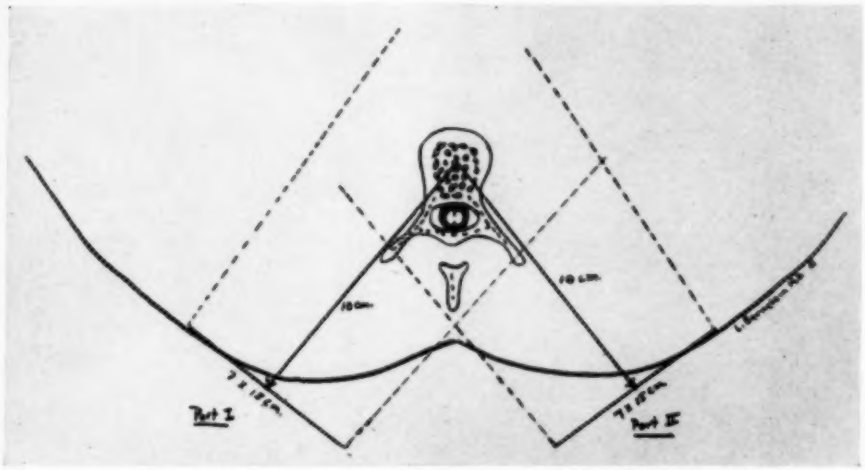


Fig. 7. Diagram illustrating protraction of x-ray beam in cross-fire of vertebral column.

When multiple lesions are demonstrated throughout the innominate bones and femoral necks, a modified pelvic cycle is often outlined. Three anterior and three posterior ports are mapped out to include the entire pelvic girdle and the femoral heads and necks (Fig. 8). The field size will vary from 8 × 12 to 10 × 15 cm.; other factors are kept constant, as described above. Two areas only are treated daily; thus each port is treated every third day. This irradiation to the pelvis is of necessity through the body, and the tube head is theoretically so angled that each lesion shall be cross-fired by two to four converging beams. Long bones are cross-fired in two to four directions, the size of port varying from 6 × 8 to 7 × 15 cm.

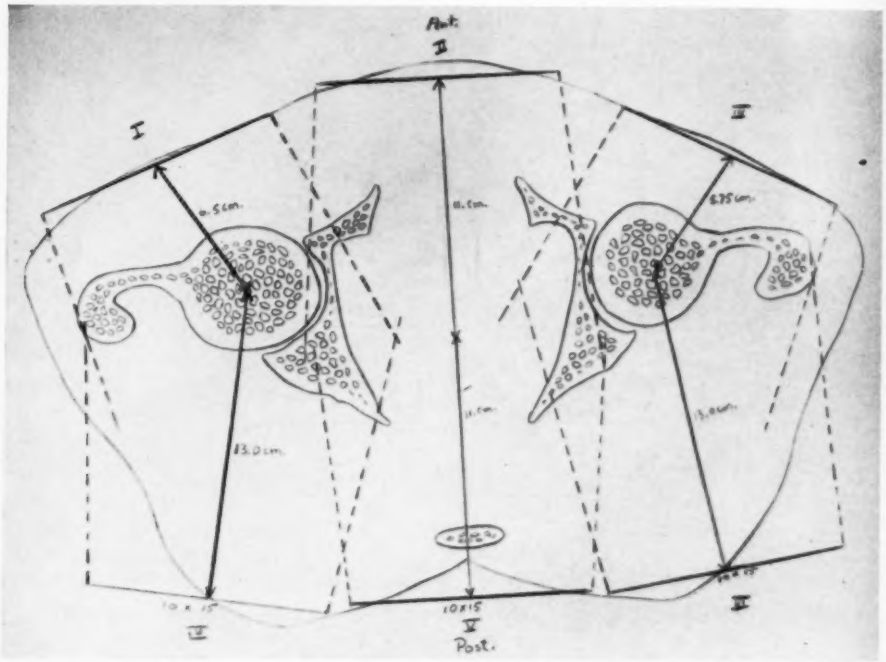


Fig. 8. Diagram illustrating ports and protraction of x-ray beam in treatment of widespread pelvic metastases.

Posterior ribs are treated by wide-angle beams to protect the underlying lung. Ports are kept small, usually 6 × 8 cm. Lateral ribs are treated through direct anterior and posterior narrow ports—5 × 7 or 5 × 10 cm.

Skin Metastases: Individual skin metastases can be destroyed by a single treatment to each lesion, with low-voltage short-target-skin-distance x-ray therapy (so-called contact therapy). A dose of 10,000 to 13,000 r is delivered to an area of 5 sq. cm. or smaller at one sitting. Multiple areas are either treated singly in this manner, or, when involvement is extensive or diffuse, the affected portion is cross-fired. In the latter case large tangential ports are used with the beam closely paralleling the surface of the body. The factors vary from 120 kv. and 0.25 mm. Cu filtration, H.V.L. 0.45 mm. Cu, T.S.D. 30 cm., to 200 kv., Thoreus filter, H.V.L. 1.8 mm. Cu, T.S.D. 50 cm. Up to 3,000 r in air is delivered to each port in fifteen days. With this angulation, there is little or no back-scatter and any point in the area cross-fired would receive in all somewhat less than 6,000 r.

Skull, Brain, and Pituitary: Here the areas are kept small; *i.e.*, 4 × 4 to 6 × 8

cm., in an attempt to cross-fire individual lesions, as in the frontal, occipital, or basilar region. As many as four ports are used in an effort to cross-fire and build up the total depth dose. Occasionally, after the patient and family consent to a permanent or temporary alopecia, larger areas up to 8 × 10 cm. are used. See Figure 9.

Mediastinum: Mediastinal extensions are cross-fired through four ports, two anterior and two posterior, their size varying from 8 × 10 to 7 × 15 cm. Other factors are kept constant, as described. Again as little lung as possible is included in the protracted beam. The dose in air to each individual port has been built up to 4,000 r. When four ports are used, each area is treated every second day.

Lung and Pleura: Pulmonary and pleural metastases furnish a serious problem. The field is cut down to about the size of the metastasis and a tumor dose of over 2,400 r or greater delivered, or large portals are irradiated, in which event the tumor dose should be limited to 1,800 r. This dose is insufficient to produce serious radiation changes in the surrounding lung.

Opposite Breast: Metastatic involvement of the opposite breast is treated through ports sufficiently large to cross-fire the entire breast, as described by Howes and Bolker (19).

Lymph Nodes: Nodes draining the opposite breast or those in any part of the body when there is wide dissemination are also cross-fired. Wherever possible, a tumor dose of 3,500 r is delivered into the node. This dose should be augmented by interstitial irradiation.

CASE REPORTS

The following case reports illustrate outstanding improvement and list type and extent of radiation therapy.

I. J., single white female, age forty, was admitted to the Brooklyn Cancer Institute on Dec. 30, 1939, with a six months' history of pain at the left costal border radiating to the back. In September 1939 she was first treated for pain, in another institution. Orthopedic appliances gave her no relief. At a second hospital, x-rays revealed destructive processes in the cervical and dorsal spine and ribs. A punch biopsy taken from one of the vertebrae was diagnosed as metastatic carcinoma. The primary tumor had not been found.

On admission to the Brooklyn Cancer Institute, the patient was unable to help herself; even to turn in bed proved to be an ordeal. Opiates were necessary and only partially controlled her pain.

Examination revealed a mass, 1.5 × 2.0 cm., in the upper outer quadrant of the left breast. This mass was stony hard, irregular, and its borders were

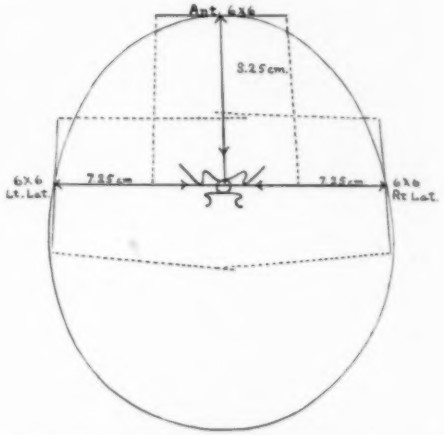
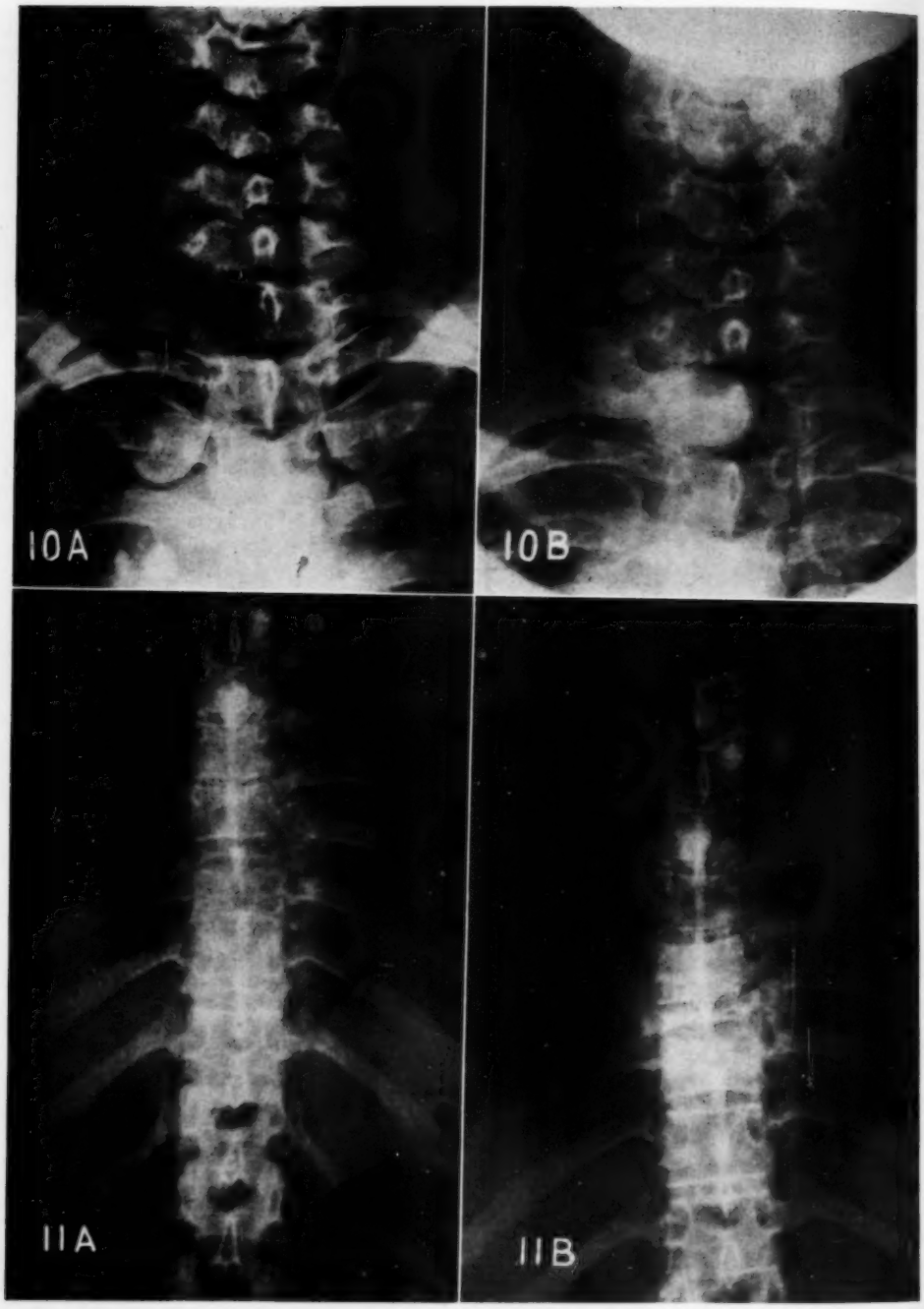


Fig. 9. Diagram illustrating ports and protraction of x-ray beam in treatment of middle cranial fossa.

ill-defined. The tumor was not attached to the skin or underlying structures. Biopsy of this nodule showed carcinoma. Roentgen examination revealed metastatic involvement of the mandible, ribs, and cervical and dorsal vertebrae (Figs. 10 and 11). Several of the vertebrae were partially collapsed. Metastases later developed in the innominate bones and both femora.

X-ray films of the dorsal and lumbar vertebrae and pelvis now show all of the lytic metastases being replaced by calcific dense bone (Figs. 10 and 11). No new metastases of importance have been found. A further extension of the primary tumor in the breast has recently been re-irradiated.

Six weeks after completion of therapy to the vertebral column (for details of irradiation see table, top of page 571), the patient was allowed to sit up and then walk, first with the aid of an orthopedic brace, later with an old-fashioned whale-bone corset. Finally, all support was discarded for a cane, and at present she walks unaided. Though a high-strung, neurotic person, she admits that her pain at present is minimal. She is anxious to go back to work as a clerk although, at the time of her admission in 1939, she had widespread bone metastases.



Figs. 10 and 11. Metastases in cervical and dorsal vertebrae before and after radiation therapy (Case I. J.).

CASE I. J.: ROENTGEN THERAPY
(Factors: 200 kv., Thoreus filter, H.V.L. 1.8 mm. Cu, T.S.D. 50 cm.)

Location	Dates	Interval (days)	Size of Port (cm.)	Number of Areas	r in Air per Port	Tumor Dose
Dorsal vertebrae	1/11/40; 2/3/40	23	7 × 15	2	2,000	3,000 r
Cervical vertebrae	1/19/40; 1/31/40	12	8 × 10	2	2,000	3,100 r
Left breast	2/5/40; 2/23/40	19	8 × 10	2	2,800	3,100 r
Lumbar vertebrae	2/26/40; 3/11/40	17	7 × 15	2	2,400	3,700 r
Sacrum	3/12/40; 3/22/40	11	8 × 15	2	2,000	3,200 r
Pituitary	6/1/40; 6/14/40	15	4 × 4	2	600	400 r
Right and left post. ribs	6/4/40; 6/21/40	18	8 × 10	4	1,200	1,900 r to each rib
Both hips with femora	11/16/40; 2/25/41	102	10 × 15	6	1,800	3,000 r
Lt. breast-extension	9/17/41; 10/18/41	31	6 × 8	2	2,600	4,300 r

A. M., thirty-nine years old, married negress, was admitted on Oct. 21, 1939, with a five months' history of intermittent itching in the region of the areola of the breast. Six weeks prior to admission she noticed a lump in the breast about the size of a walnut and was admitted to another hospital, where a diagnosis of carcinoma was made and confirmed by biopsy. Metastases were demonstrated in the skull, ribs, and dorsal and lumbar vertebrae. The patient was referred to the Brooklyn Cancer Institute, where additional secondary deposits were found in the pelvis. X-ray therapy was carried out as shown in the following table.

CASE A. M.: ROENTGEN THERAPY

Location	Dates	Interval (days)	Size of Port (cm.)	Number of Areas	r in Air per Port	Tumor Dose
Lower dorsal and lumbar spine and sacrum	10/28/39; 11/22/39	24	5 × 20	2	2,200	3,600 r
Cervical vertebrae	11/22/39; 12/5/39	13	6 × 8	2	2,000	4,800 r
Left breast	12/6/39; 12/21/39	15	10 × 15	2	2,400	3,600 r
Calvarium	2/6/40; 2/9/40	4	8 × 10	2	400	600 r
Left petrous bone	3/19/40; 4/9/40	17	4 × 4	2	2,000	1,300 r
Pelvis	1/2/41; 3/6/41	34	10 × 15	6	1,600	2,600 r to lat., 2,200 r to center
Sella turcica	1/14/41; 2/5/41	21	4-cm. circle	2	2,000	1,000 r
Mid-dorsal vertebrae	2/6/41; 3/7/41	29	7 × 15	2	1,600	1,300 r
Left knee	2/25/41; 3/27/41	31	8 × 10	2	2,000	3,500 r
Right knee	3/10/41; 3/29/41	19	8 × 10	2	1,800	3,100 r

Calcium deposition and new bone formation are now demonstrable on x-ray films (Fig. 12).

Two years have elapsed since metastases were noted. The patient is ambulatory, comfortable, and reports that she is able to carry out her daily household duties.

CONCLUSIONS

1. Symptoms due to widespread metastases secondary to mammary carcinoma are alleviated by direct irradiation.

2. Bone metastases respond to direct irradiation by recalcification, appearance of new bone formation, and healing of pathological fractures. Skin metastases can be destroyed. Visceral metastases, except those in the liver, are often improved.

3. Eighty-three patients irradiated at the Brooklyn Cancer Institute lived on an average of twenty months, as compared with an estimated five months' survival period for untreated patients.

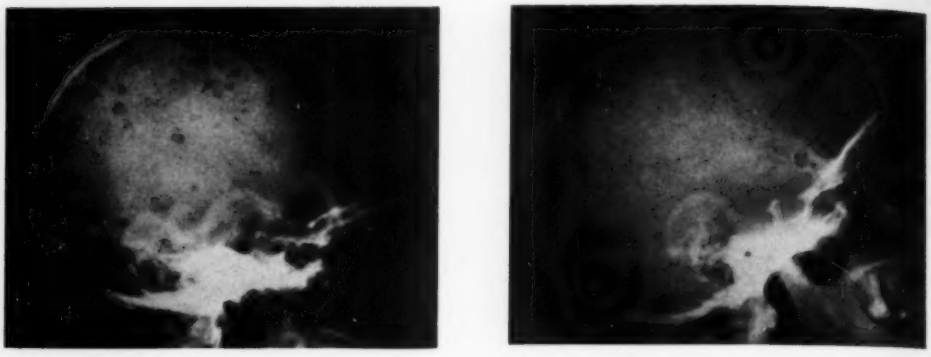


Fig. 12. Metastases in calvarium before and after radiation therapy (Case A. M.)

4. Two case reports are presented to illustrate outstanding improvement following irradiation.

152 Clinton St.
Brooklyn, N. Y.

BIBLIOGRAPHY

1. PFAHLER, G. E.: Roentgen Treatment of Metastatic Carcinoma of Bone. Acta radiol. **7:** 280–288, 1926.

2. LEE, BURTON JAMES, AND HERENDEEN, RALPH E.: Treatment of Primary Inoperable Carcinoma of the Breast by Radiation: Report of 54 Cases from the Breast Clinic. Radiology **2:** 121–136, March 1924.

3. LEDDY, EUGENE T.: Roentgen Treatment of Metastasis to Vertebrae and Bones of Pelvis from Carcinoma of Breast. Am. J. Roentgenol. **24:** 657–672, December 1930.

4. FREUND, LEOPOLD: Röntgenbehandlung der Ischias. Wien. klin. Wchnschr. **20:** 1611–1612, 1907 (quoted by Leddy).

5. MATTHEWS, A. A.: Secondary Carcinoma of Bone. New York M. J. **101:** 1150–1157, 1915 (quoted by Leddy).

6. LEDDY, EUGENE T., AND DESJARDINS, ARTHUR U.: Treatment of Inoperable Recurrent and Metastatic Carcinoma of the Breast. Am. J. Roentgenol. **35:** 371–383, March 1936.

7. SMITH, L. W., AND FAY, TEMPLE: Temperature Factors in Cancer and Embryonal Cell Growth. J. A. M. A. **113:** 653–660, Aug. 19, 1939.

8. SANO, M. E., AND SMITH, L. W.: Critical Histopathologic Study: 60 Post-Mortem Patients with Cancer Subjected to Local or Generalized Refrigeration Compared to Similar Control Group of 37 Nonrefrigerated Patients. J. Lab. & Clin. Med. **26:** 443–456, December 1940.

9. VAUGHN, A. M.: Experimental Hibernation of Metastatic Growths: Preliminary Report. J. A. M. A. **114:** 2293–2298, June 8, 1940.

10. SCHINZINGER, V.: Carcinoma Mammae. Verhandl. d. deutsch. Gesellsch. f. Chir. **18:** 28–29, 1889 (quoted by Dresser).

11. BEATSON, G. T.: On the Treatment of Inoperable Cases of Carcinoma of the Mamma: Suggestions for a New Method of Treatment, with Illustrative Cases. Lancet **2:** 104–107, 162–165, 1896.

12. DRESSER, RICHARD: Effect of Ovarian Irradiation on Bone Metastases of Cancer of the Breast. Am. J. Roentgenol. **35:** 384–388, March 1936.

13. FOVEAU DE COURMELLES: Les rayons X et le radium en therapeutique gynécologique. Acta radiol. **6:** 322–326, 1926.

14. AHLBOM, H.: Castration by Roentgen Rays as an Auxiliary Treatment in Radiotherapy of Cancer Mammae at Radiumhemmet, Stockholm. Acta radiol. **11:** 614–633, 1930.

15. DALAND, E. M.: Analysis of Cases at the Pondville Hospital: Cancer of Breast. Am. J. Cancer **15:** 2361–2366, July 1931.

16. DALAND, E. M.: Personal communication, Nov. 18, 1941.

17. MEYERDING, H. W., CARMAN, R. D., AND GARVIN, J. D.: Metastasis to the Bones from Carcinoma of the Breast: Roentgenologic Study. Radiology **5:** 486–489, December 1925.

18. CLARKSON, WRIGHT, AND BARKER, ALLEN: Five Year Cure of Mammary Carcinoma with Multiple Metastases to Bone. Am. J. Roentgenol. **36:** 615–621, November 1936.

19. HOWES, WM. E., AND BOLKER, HERMAN: Preoperative Irradiation of the Breast. Am. J. Roentgenol. **44:** 98–104, July 1940.

The Roentgenologic Appearance of the Heart in Toxic Adenoma and Graves' Disease[1]

GEORGE LEVENE, M.D., and LOIS C. MILLER, M.D.
Boston, Mass.

IT IS GENERALLY conceded that in patients with thyrotoxicosis the roentgenologic appearance of the heart varies greatly. In order to determine whether its size and configuration conformed to any particular pattern, a group of 96 cases was studied. For purposes of comparison 26 patients with non-toxic adenomas of the thyroid and 100 persons without either heart or thyroid disease were examined. Such factors as age, duration, and severity of the thyrotoxicosis were studied in relation to the size and configuration of the heart. In addition, the influence of such associated features as auricular fibrillation, congestive heart failure, organic heart disease, and compression of the trachea was noted. In 39 patients comparative studies were made before and after thyroidectomy.

The extensive literature dealing with the size and contour of the heart in thyrotoxicosis is not in agreement. A lack of unanimity is found, also, in descriptions of the histopathological changes in the heart in these patients. Weller, Wanstrom, Gordon, and Bugher (1) observed a high incidence of myocardial fibrosis (80 per cent as compared with 50 per cent in the controls). Parkinson and Cookson (2) reported enlargement of the heart in their series of 43 autopsied cases. They believed, however, that the histologic changes were consistent with the usual autopsy findings in that age group (over forty years). In 89 fatal cases, Kepler and Barnes (3) found increased heart weight in 49 per cent. Foss (4) reported cardiac enlargement in 26 per cent of the toxic adenomas and 23 per cent of the exophthalmic goiters in a roentgenologic study of 2,000 cases. Burnett and Durbin (5) found cardiac enlargement in one-third of their patients. Willius and Boothby (6) noted cardiac enlargement in their fatal cases, but Wilson (7), commenting on this report, could see nothing distinctive in the histologic studies of these hearts. According to Webster and Cooke (8) there are increase in the water content of heart muscle (81.9 per cent as compared with 75.6 per cent in the normal), edema, and a decrease in the number of fibers and disappearance of perinuclear sarcoplasm. These observations were not confirmed by Bodansky (9), who reported true hypertrophy of the myocardium, resulting in enlargement of the heart. He found no increase in the water content of the heart muscle, but a marked depletion of creatine and phosphocreatine, which he believed to be the important factor in the production of heart failure in thyrotoxicosis. Cabot (10)

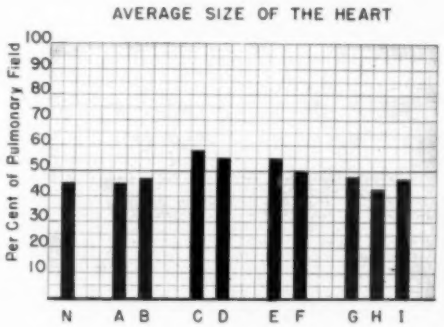


Fig. 1. The average size of the heart in relation to the internal diameter of the chest. N. Normal. A. Uncomplicated thyrotoxicosis before operation. B. Same group as A, after operation. C. Thyrotoxicosis complicated by cardiac failure or associated heart disease, before operation. D. Same group as C, after operation. E. Thyrotoxicosis with auricular fibrillation, before operation. F. Same group as E, after operation. G. Thyrotoxicosis with tracheal compression. H. Non-toxic adenomas with tracheal compression. I. Toxic adenomas without tracheal compression.

[1] From the Evans Memorial for Clinical Research and Preventive Medicine, Massachusetts Memorial Hospitals, Boston, Mass. Accepted for publication in February 1942.

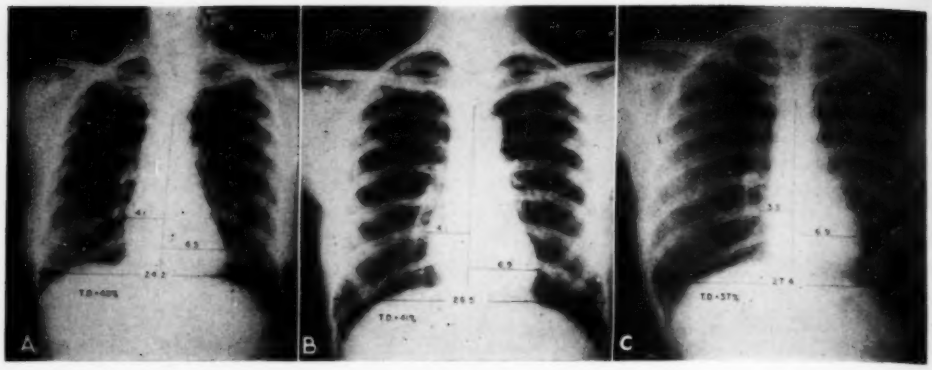


Fig. 2. Contours of the heart in thyrotoxicosis. A. Type I. The left border of the heart, from aortic knob to apex, forms a straight line. B. Type II. The left border of the heart is concave. This is most marked at the auriculoventricular junction and is exaggerated during deep inspiration. The pulmonary artery is prominent. C. Type III. The normal contour. These types appear in the order described, in relation to the duration and severity of the disease. There is also a progressive decrease in the transverse diameter of the heart.

denied that the heart may be enlarged in thyrotoxicosis. Poppi (11) was of the opinion that there is concentric ventricular hypertrophy but that the heart is not enlarged in thyrotoxicosis since it corresponded with the normal average predicted size and weight in the cases studied.

The inadequacy of any method of measurement in determining changes in the size of the heart due to thyrotoxicosis lies in the uncertain knowledge of its size before the onset of the disease. In the present study this deficiency was met in part by comparing the size of the heart in 39 cases before and after operation and clinical cure. The method of study consisted of fluoroscopic examination and measurement of the teleroentgenogram. In the latter, we measured the transverse diameter of the heart (right and left median diameters) and the transverse diameter of the lungs. For purposes of comparison the same measurements were made in 100 patients who were known to be free of heart disease or thyrotoxicosis. In this normal group, the average transverse diameter of the heart was 45.3 per cent of the transverse diameter of the lungs.

SIZE

It is generally agreed that an increase in the transverse diameter of the heart beyond 50 per cent of the transverse diameter of the pulmonary field indicates cardiac enlargement. On the basis of this criterion, 83.3 per cent of the cases of uncomplicated thyrotoxicosis showed no enlargement of the heart. In toxic adenoma the average size was 44.8 per cent of the pulmonary field, while in patients with Graves' disease it was 45.6 per cent; the average for the entire group was 45 per cent (Fig. 1).

We considered thyrotoxicosis to be complicated if there was associated auricular fibrillation, cardiac decompensation, or arteriosclerotic, hypertensive, rheumatic, or syphilitic heart disease. In this group, which numbered 17 cases, the hearts were enlarged, the average measurement being 58 per cent of the average pulmonary field.

In order to evaluate the effect of tracheal compression on the size of the heart, a study was made of a group of 26 non-toxic goiters with deviation and compression of the trachea. In no case of this group did the transverse diameter of the heart exceed 50 per cent of that of the pulmonary field.

After operation, cases of uncomplicated toxic adenoma or Graves' disease showed an increase in the size of the heart, the average transverse diameter in the group being 47 per cent of that of the pulmonary field. This represents an average increase

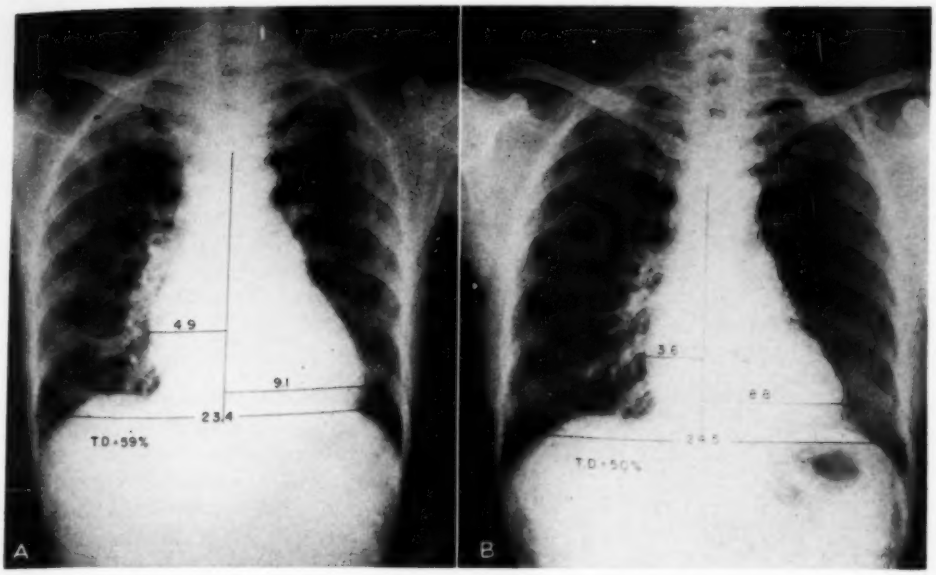


Fig. 3. A. Thyrotoxicosis with auricular fibrillation and left ventricular failure. There is an increase in the transverse diameter. B. Heart compensated and normal rhythm restored Heart has returned to within normal limits of size.

of 4.4 per cent in the size of the heart, which may possibly be accounted for by a decrease in heart rate after operation.

Thyrotoxicosis associated with auricular fibrillation or heart failure, or complicated by organic heart disease, showed a decrease in the transverse cardiac diameter after operation. From 58 per cent of the pulmonary field preoperatively, it was reduced to 55 per cent postoperatively—a decrease of 5.2 per cent.

CONTOUR

Three types of cardiac contour were found in uncomplicated thyrotoxicosis, as follows.

Type I: The left border of the heart, from the region of the aortic knob to the apex, formed a straight line (Fig. 2-A). The lateral convexities normally produced by the pulmonary artery, the left auricle, and the left ventricle were diminished or absent. This appears to be the earliest change in relation to the duration and severity of the disease.

Type II: The left border of the heart was concave, particularly in the region of the auriculoventricular sulcus (Fig. 2-B). This concavity was accentuated during deep inspiration. The pulmonary artery was prominent and projected laterally beyond the base of the heart. This type was frequently seen in cases of longer duration or greater severity than Type I.

Type III: The normal contour (Fig. 2-C) was observed in cases of longest duration and greatest severity.

Auricular fibrillation or cardiac decompensation were found in cases associated with any type of contour. With the advent of auricular fibrillation there was widening of the base of the heart. The appearance of heart failure was accompanied by an increase in transverse cardiac diameter and a variable degree of congestive infiltration of the lungs (Fig. 3).

FLUOROSCOPIC APPEARANCES

In toxic adenoma and Graves' disease there is an increase in the rate and amplitude of cardiac contractions. Since the heart rate of even normal persons is likely to be accelerated due to apprehensiveness in a fluoroscopic room, it is well to allow

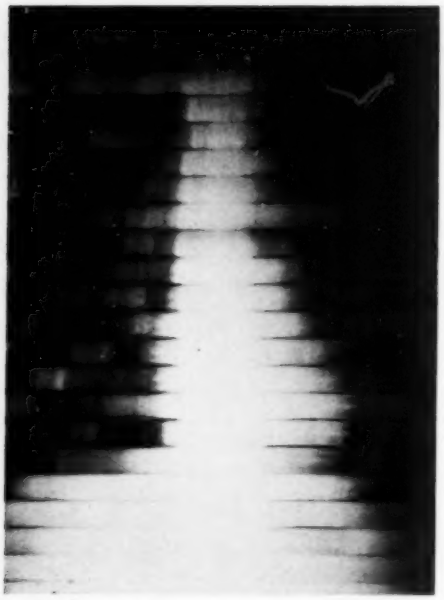


Fig. 4. Kymogram showing increased rate and amplitude typical of thyrotoxicosis.

the patient a little time to become accustomed to the surroundings. At rest, the heart rate in thyrotoxicosis is usually 100 or more per minute. This tachycardia is associated with an increase in the amplitude of contractions of the entire cardiovascular shadow, resulting in the typical forceful heaving beat (Fig. 4). In the frontal view, the amplitude of left ventricular contractions may exceed 7 mm. and in the left anterior oblique position it may be as great as 12 mm. The aorta may show a rapid diastolic collapse simulating the appearance of aortic insufficiency, and not infrequently there are autochthonous pulsations of the hilar vessels. If there is no pulmonary congestion, the lungs are usually quite luminous and the diaphragm is low.

Auricular fibrillation is the most common arrhythmia in thyrotoxicosis; it was present in 20 per cent of our cases. The amplitude of contractions in auricular fibrillation occurring in thyrotoxicosis is usually greater than that seen in rheumatic or arteriosclerotic heart disease.

APPEARANCE AFTER OPERATION

In 57 per cent of the cases of uncomplicated thyrotoxicosis the contour of the heart changed after operation. Most of these returned to normal and in only a few instances did the heart assume the contour of another type. Under the fluoroscope, the heart rate and amplitude of contractions were normal. A few cases showed lateral deviation of the trachea, probably as a result of adhesions.

DISCUSSION

From our observations the size of the heart in thyrotoxicosis seems to depend on several factors. In over 83 per cent of our cases there was no enlargement. We are of the opinion that there is, instead, a slight reduction in size. This is probably best explained by the accelerated heart rate. A decrease in the size of the heart is seen to occur during attacks of paroxysmal tachycardia. This belief is strengthened by comparative studies made during the height of thyrotoxicosis and after its cure, which showed the heart to be slightly larger after

Contour	Per Cent of Pulmonary Field	Average B.M.R.	Average Duration
TYPE 1	48.3	+41	8 months
TYPE 2	46.5	+41	18 months
TYPE 3	42.9	+47	31 months

Fig. 5. Chart showing progressive diminution of heart size as severity and duration of thyrotoxicosis increase.

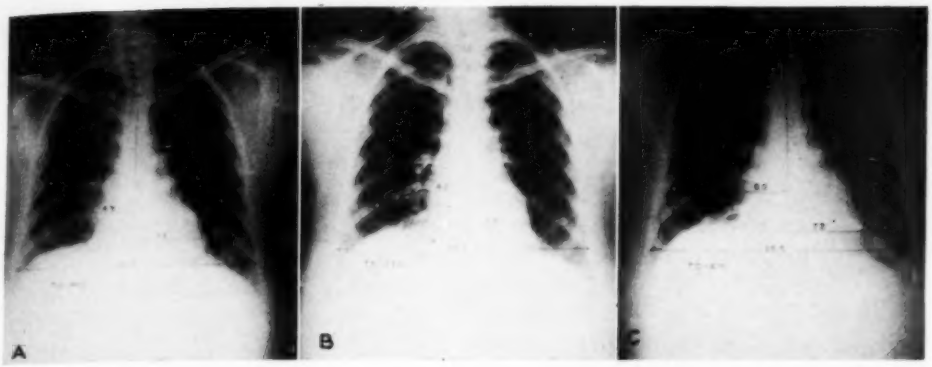


Fig. 6. A. Heart before thyrotoxicosis. Transverse diameter of the heart is 46 per cent of that of pulmonary field. B. During stage of active symptoms of hyperthyroidism. Transverse diameter is 42 per cent of that of pulmonary field. C. Two years after disappearance of symptoms of thyrotoxicosis. Transverse diameter is 47 per cent of that of pulmonary field.

operation. Moreover, there was a decrease in the transverse diameter of the heart with increasing duration of the disease (Fig. 5). Further supportive evidence was obtained in a case of self-induced thyrotoxicosis, in which we were fortunate to secure a roentgenographic record before, during, and after the development of the disease. The patient was a young woman who took large doses of desiccated thyroid gland (at times reaching 15 grains a day) to effect a reduction in body weight. During the height of symptoms, the heart became smaller (Fig. 6). Two years later, after symptoms had completely subsided and there was no clinical evidence of hyperthyroidism, the heart increased in size to what it had been before the onset of thyrotoxicosis.

Our conclusions are not fully in agreement with those of other observers. Hurxthal, Menard, and Bogan (12) could find no relationship between the duration of the disease and the size of the heart. Rosenblum and Levine (13) showed a slight reduction in the cardiothoracic ratio after thyroidectomy. Their series, however, was too small to permit any conclusion and, judging from their tabulated data, it is possible that the cases studied by them were not uncomplicated thyrotoxicosis in the sense of the present report.

Margolies, Rose, and Wood (14) classified the hearts in their cases of uncomplicated thyrotoxicosis as small, of normal size, and enlarged. In their group with small hearts, 100 per cent showed increase in size after thyroidectomy. There was an increase in size in 21 per cent of the normal-sized hearts after operation. Their measurements were based on estimation of cardiac area and comparison with predicted size according to weight and height. Since, in thyrotoxicosis, the reduction in weight of any single organ is not proportionate to the reduction in general body weight, it would appear that this method of study would detect an increase in the size of the heart more readily than a decrease.

When thyrotoxicosis was complicated by auricular fibrillation, ventricular failure, or associated heart disease of other cause, the heart was usually enlarged. In these cases the heart was found to average 58 per cent of the pulmonary field before, and 55 per cent after operation. It would seem that enlargement in these cases was due more to the associated heart disease than to thyrotoxicosis.

Tracheal compression, of itself, was apparently not a factor in the production of cardiac enlargement. In a series of 26 uncomplicated cases of non-toxic adenoma of the thyroid showing compression of the trachea, there was no enlargement of the heart in any instance, the average transverse cardiac diameter being 43 per cent of the pulmonary field.

SUMMARY AND CONCLUSIONS

1. In thyrotoxicosis (toxic adenoma or Graves' disease) the heart is usually not enlarged unless there is auricular fibrillation, congestive heart failure, or associated heart disease.

2. Patients with uncomplicated thyrotoxicosis show an increase in the transverse diameter of the heart following thyroidectomy. This suggests that during the active stage of the disease the heart is reduced in size.

3. When thyrotoxicosis is complicated by rheumatic, arteriosclerotic, or hypertensive heart disease, there is enlargement of the heart. This is somewhat reduced after thyroidectomy.

4. Cardiac enlargement accompanying failure is reduced after operation.

5. Three types of cardiac contour are observed in thyrotoxicosis. In *Type I* the left border of the heart is straight; the lateral convexities normally produced by the pulmonary artery, left auricle, and left ventricle are greatly diminished. In *Type II* the left border of the heart is concave. This is most marked at the auriculoventricular junction and is exaggerated during deep inspiration. The pulmonary artery is unduly prominent and may project laterally beyond the base of the heart. *Type III* is the normal contour. These types appear in the order described in relation to the duration and severity of the disease. They are all associated with increased rate and amplitude of contractions.

6. Compression of the trachea by an enlarged cervical or substernal thyroid does not cause enlargement of the heart.

750 Harrison Ave., Boston, Mass.

BIBLIOGRAPHY

1. WELLER, C. V., WANSTROM, R. C., GORDON, H., AND BUGHER, J. C.: Cardiac Histopathology in Thyroid Disease. Preliminary Report. Am. Heart J. **8:** 8–18, October 1932.

2. PARKINSON, J., AND COOKSON, H.: Size and Shape of Heart in Goitre. Quart. J. Med. **24:** 499–532, July 1931.

3. KEPLER, E. J., AND BARNES, A. R.: Congestive Heart Failure and Hypertrophy in Hyperthyroidism: Clinical and Pathological Study of 178 Fatal Cases. Am. Heart J. **8:** 102–108, October 1932.

4. FOSS, H. L.: The Heart in Toxic Goiter. Pennsylvania M. J. **39:** 671–681, June 1936.

5. BURNETT, C. T., AND DURBIN, E.: Signs and Symptoms of Heart Changes in Toxic Goiter: Clinical Study of 148 Cases. Am. Heart J. **8:** 29–40, October 1932.

6. WILLIUS, F. A., AND BOOTHBY, W. M.: Heart in Exophthalmic Goiter and Adenoma with Hyperthyroidism. M. Clinics N. America **7:** 189–219, July 1923.

7. WILSON, L. B.: Discussion of pathological findings in "Heart in Exophthalmic Goiter and Adenoma with Hyperthyroidism," by Willius, F. A., and Boothby, W. M. M. Clinics N. America **7:** 189–219, July 1923.

8. WEBSTER, B., AND COOKE, C.: Morphologic Changes in the Heart in Experimental Myxedema. Arch. Int. Med. **58:** 269–277, August 1936.

9. BODANSKY, M.: The Effect of Thyroid and Thyroxine on the Concentration of Creatine in the Heart Muscles, Liver and Testes of the Albino Rat. J. Biol. Chem. **109:** 615–622, May 1935.

10. CABOT, R. C.: Facts on the Heart. Philadelphia, W. B. Saunders Co., 1926, pp. 615–622.

11. POPPI, A.: The Small Heart in Flajani-Basedow's Disease. Cuore e circolaz. **24:** 169–201, May 1940.

12. HURXTHAL, L. M., MENARD, O. J., AND BOGAN, M. E.: Size of the Heart in Goiter. Am. J. M. Sc. **180:** 772–781, December 1930.

13. ROSENBLUM, H. H., AND LEVINE, S. A.: What Happens Eventually to Patients with Hyperthyroidism and Significant Heart Disease Following Subtotal Thyroidectomy. Am. J. M. Sc. **185:** 219–233, February 1933.

14. MARGOLIES, A., ROSE, E., AND WOOD, F. C.: The Heart in Thyroid Disease. I. The Effect of Thyroidectomy on the Orthodiagram. J. Clin. Investigation **14:** 483–496, July 1935.

Gaucher's Disease[1]

JAMES REED, M.D.,[2] Farmington, Maine
and
MERRILL C. SOSMAN, M.D., Boston, Mass.

GAUCHER'S DISEASE is a somewhat rare familial disturbance of the cellular metabolism in the reticulo-endothelial cells and histiocytes, characterized by an accumulation and retention of the cerebroside kerasin. Thannhauser and his associates (1) explain this deviation from the normal lipid metabolism as an imbalance of intracellular enzymes concerned with the disintegration and synthesis of sphingomyelin and kerasin within the cell and a resulting accumulation of kerasin.

The clinical manifestations may be enlargement of the spleen, liver, and sometimes the lymph nodes, pigmentation of the skin, pinguecula-like lesions of the conjunctivae, thrombocytopenia, and frequently a leukopenia. There may be pain in some portion of the osseous system caused by destructive infiltration of the cerebrosidic reticulosis of the bone marrow, and osseous involvement may be the earliest and continue to be the predominating manifestation of the disease. An accompanying fever and leukopenia are usually present. It is of the predominantly osseous type with which this case report deals.

Risel (2) was the first to note macroscopic bone changes in Gaucher's disease and described the spongiosa at the upper and lower ends of the femur dotted with rather small, thick, whitish areas, arranged in a stellate form either in nodes or streaks or in a net-like manner. These areas represented deposits of Gaucher cells. The first complete x-ray studies were made by Klercker (3) and Junghagen (4) in 1926. The earliest as well as the most consistent type of change usually occurs as a widening of the lower ends of the femur, just above the condyles (Fischer's sign). This is followed by areas of rarefaction with intermingled areas of sclerosis and a resulting club-shaped conformation. The severe pain over this region when the changes begin to take place, accompanied by fever, makes it easy to confuse this condition with acute osteomyelitis. A history of some preceding trauma can almost always be obtained and, despite the low-grade fever and lack of leukocytosis, operation may be performed. The finding of a sterile pus from which no organism can be grown, coupled with the other findings atypical of acute osteomyelitis, may help to throw doubt on this diagnosis. Once operation has been done, drainage may continue for months.

Bony changes occur frequently in the humerus, tibia, fibula, radius, ulna, and ribs. Changes have also been described in the pelvis and skull. Of those cases described in the literature, the most common changes in the long bones include general osteoporosis, large areas of destruction of the spongiosa, and as a late manifestation punched-out areas in the bone with irregular thickening of the cortex. Pathological fractures have been noted in long bones with a destructive lesion. Similar destructive changes in the head of the femur may result in a deformity which must be differentiated from Legg-Perthes' disease, tuberculous coxitis, and chronic osteomyelitis. Involvement of the spine may result in compression deformities of the vertebral bodies. The intact disc differentiates this condition from tuberculosis.

In the case to be reported the changes have differed somewhat from those described above.

CASE REPORT

B. C., a 21-year-old unmarried Jewish girl, entered the Peter Bent Brigham Hospital on Feb. 5, 1941. She was the third of a family of six children, three

[1] From the Department of Roentgenology, Peter Bent Brigham Hospital, Boston, Mass. Accepted for publication in February 1942.

[2] Commonwealth Fellow in Roentgenology, 1941.

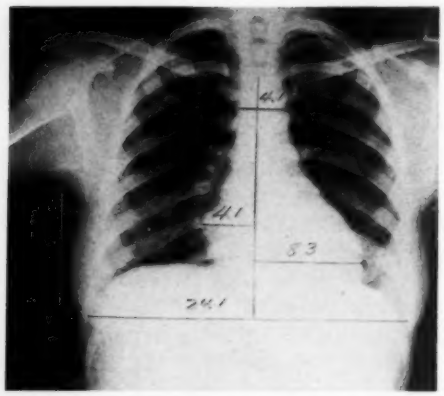


Fig. 1. A 7-foot film of the heart showing slight enlargement downward and to the left. The lungs are clear.

brothers and three sisters, without history of familial disease.

As a child the patient had measles, whooping cough, chickenpox, and scarlet fever. A tonsillectomy was performed in 1924 at the Children's Hospital. In 1929 she entered the Carney Hospital, where she was operated on for osteomyelitis of the lower third of the *left* femur. In 1932 drainage of osteomyelitis of the lower third of the *right* femur was done at the Boston City Hospital. Two years after the second operation the wound stopped draining and healed. From that time on the patient was apparently in good health until early in 1939. She entered the hospital from the out-patient department, where she had been followed for the previous year and a half. She had a two-year history of recurring migratory joint symptoms affecting the hands, wrists, elbows, hips, knees, and feet. The joints would become swollen, hot, and painful, with limitation of motion. Symptoms would persist for a day or longer and then would subside only to appear in another group of joints. The adjacent soft tissue also would become swollen. Between episodes the joints would appear perfectly normal with no tenderness or limitation of motion. Active use of these joints and exposure to cold would tend to make the symptoms appear. The picture was not unlike that of rheumatic fever.

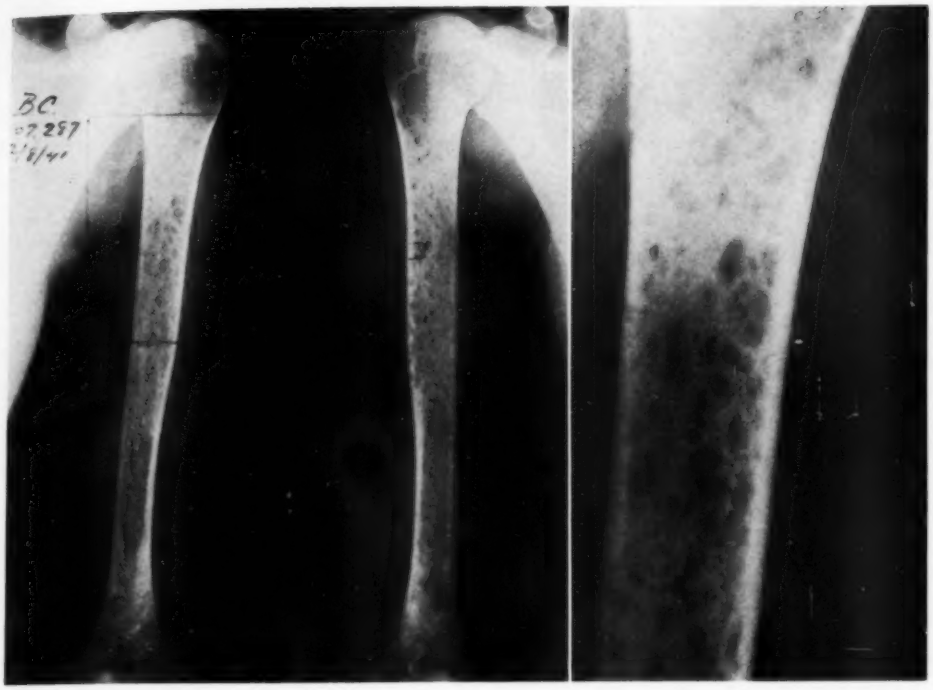
On physical examination the findings of note were a rough grade II systolic murmur in the pulmonary area, a slight anemia of 3.7 to 4.0 million red blood cells, and a white blood cell count of 5,000 to 6,000, which was noted throughout the course of the illness. X-rays of the chest showed the heart slightly enlarged downward and to the left (Fig. 1), and an electrocardiogram disclosed a delayed A.V. conduction time. X-rays of the hands in February 1940 showed narrowing of the interphalangeal joints without erosion suggestive of early atrophic (rheumatoid) arthritis. Nine months before admission small subcutaneous nodules were noted on the posterior aspects of both arms, lasting several days and leaving ecchymotic spots as they subsided. Tenderness in the left upper quadrant was noted by several observers. The spleen, however, was not felt.

During the year previous to admission the patient had frequent sore throats and episodes of epistaxis. She gave up work entirely in the last half of this period and rested at home, with considerable relief from symptoms. During this time her appetite was poor, she lost seven pounds, and there was a tendency to bruise easily.

Physical examination on admission showed a well developed and well nourished girl, who did not appear ill. The heart did not appear enlarged to percussion or palpation. There was a soft systolic murmur at the apex and a rather harsh systolic murmur in the pulmonary area. There was a loud second sound. The lungs were normal. The abdomen showed an area of tenderness on deep palpation just lateral to and above the umbilicus on the left side. A moderate enlargement of the metacarpophalangeal joints of both hands with soft tissue swelling over the dorsum of the hands and a spindle-shaped appearance of the digits were noted. The joints were not hot or painful and there was no limitation of motion. All other joints were normal. There was a long scar on the lateral aspect of the left thigh and a smaller scar on the lower medial aspect of the right thigh. Over the apex of the root of the left upper canine tooth was a small, acutely tender nodule. Numerous small areas of ecchymosis were scattered over the body and extremities.

Laboratory data while the patient was in the hospital were as follows: Urine concentrated to 1.012 with occasional white blood cells in the non-catheterized specimen. No casts or Bence-Jones protein were found. Red blood cells 3,900,000; hemoglobin 9.6 gm. per cent; hematocrit 33 per cent; sedimentation rate 18 mm./hour on one occasion and 15 mm./hour on another; white cells 5,000, 65 per cent neutrophils, 26 per cent lymphocytes, 3 per cent monocytes. Red cells showed marked variation in size with some chromatophilia. Reticulocytes 2.8 per cent. Blood chemistry: non-protein nitrogen 26 mg. per cent; cholesterol 149 mg. per cent; protein 7 gm. per cent; albumin 4.5 gm. per cent; globulin 2.5 gm. per cent; calcium 4.9 m.e. liter; phosphorus 1.1 m.e. liter; alkaline phosphatase 1.8 Bodansky units. Stool negative. Formol-gel and Takata-Ara tests negative. Clotting time eight minutes.

The patient was first seen in the x-ray department a year and a half before admission to the hospital, when chest films were taken. At that time there was a hyperactive beat and a slight enlargement of the left ventricle. A peculiar mottling of the portion of the humeri seen in the chest films was noted, and films of the humeri were requested at this time but the patient did not return to the department. Six months later films of the hands and wrists were



Figs. 2 and 3. The humeri show peculiar coarse oval and irregular defects on the inner surface of the cortex. Note the apparent expansion of the medullary cavity in the lower ends of the humeri. Fig. 3 (right) shows detail in the upper end of the left humerus.

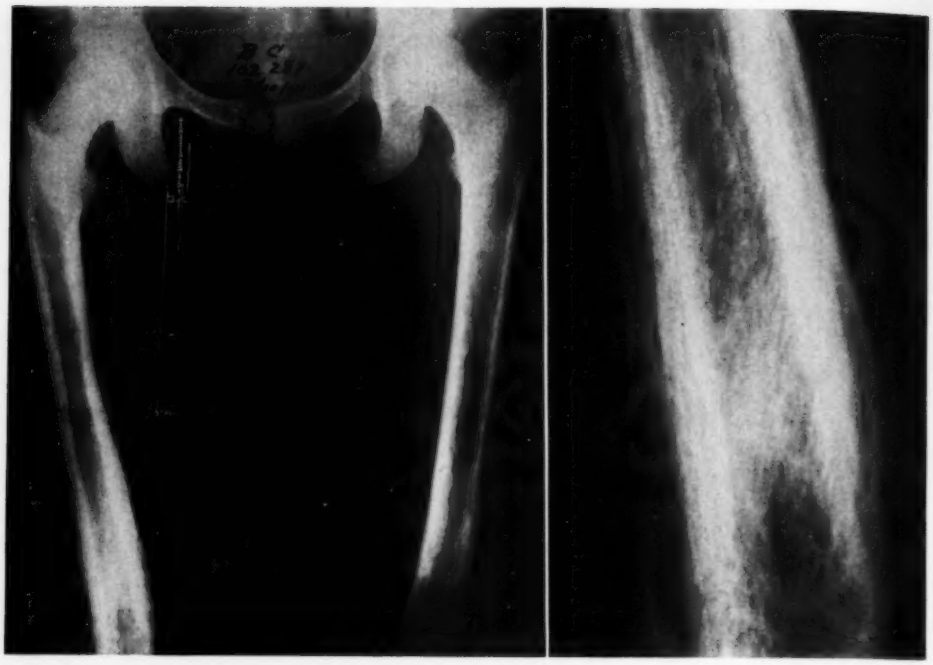
taken and a narrowing of the interphalangeal joints without erosion or destruction was noted.

During the patient's hospital stay extensive x-ray studies of the bones were made. The findings were somewhat at variance with those commonly described in Gaucher's disease. Films of the spine were essentially normal. A rather fine granular appearance was noted in the skull and pelvis. The most marked changes were in the femora and humeri, with similar but less pronounced changes in the tibiae and radii and no involvement of fibulae and ulnae. The humeri (Fig. 2) presented an unusual appearance, with multiple small, irregular defects in the cortex of the shaft. The lesions were not circular and clean-cut as in multiple myeloma but were more elongated and oval without bone reaction around them. The appearance was more that of a spreading apart of the trabeculae than of a destruction of bone. The lower (distal) thirds showed an apparent expansion of the medullary cavity simulating a proliferation of the bone marrow expanding the bone. Figure 3 shows the changes in the upper end of the left humerus in better detail. The femora are shown in Figure 4. The most striking changes were in the lower thirds, where there were widening of the bones and marked thickening of the cortex rather than the thinning usually observed. The upper half of each femur had a hollowed, tunneled-out appearance, resembling somewhat the changes seen in caisson disease involving this bone. The femoral heads showed coarse trabeculae and small cysts. Figure 5 shows the changes in the lower third of the right femur in better detail. The changes in the tibiae were similar to, but less marked than those in the humeri, and growth-arrest lines were present in the upper ends. The only changes seen in the radii consisted of expansion of the medullary cavities in the upper thirds. A film of the abdomen showed a considerably enlarged liver and a moderately enlarged spleen, although the spleen could not be felt on physical examination.

On the strength of the x-ray findings, bone biopsy was recommended, and on the fifteenth hospital day biopsy of the humerus was done. Sections revealed characteristic Gaucher cells. Abdominal films as well as films of the humeri and femora of both parents and 5 siblings were taken. No evidence of Gaucher's disease was found in any of them.

DISCUSSION

This case has presented several interesting aspects. The patient was operated on for osteomyelitis on two occasions. This



Figs. 4 and 5. The femora show two types of change, both different from those in the humeri. The marked periosteal overgrowth on the lower end of the right femur may be in part due to the previous operation and long-continued drainage. The large oval expansions of the medullary cavity in the left femur are more suggestive of Gaucher's disease. Fig. 5 (right) shows detail in the lower end of the right femur.

same mistake has been made in other cases of Gaucher's disease. The spleen was relatively small and could not be palpated, although shown to be demonstrably enlarged by x-ray examination. Clinically there was a confusing similarity to a smoldering rheumatic fever. Lupus erythematosus disseminatus could not be ruled out before admission to the hospital. The x-ray findings varied from those usually described. The cardiac findings are the most intriguing of all. It is interesting to conjecture whether or not the delayed conduction time and cardiac enlargement could be due to the presence of Gaucher cells. Histologically this would not be impossible.

In generalized xanthomatosis the presence of xanthomatous deposits in the endocardium, the valves, the pulmonary and coronary arteries, and the aorta and carotid arteries is not rare. Although the presence of kerasin within the cells would be due to an entirely different mechanism, it seems equally possible that this condition could occur. A search of the literature has not revealed any case in which myocardial involvement was described. An autopsy of one patient with Gaucher's disease is reported to have shown hemorrhagic pericarditis and in another a calcified pericardium was found, but no case report was discovered where the disease could be demonstrated in the myocardium.

SUMMARY

1. A case of Gaucher's disease is reported in which the clinical picture, the physical examination, and the roentgenographic findings were all somewhat at variance with those described in textbooks.

2. Roentgen examination gave the first clue to the correct diagnosis.

3. A palpably enlarged spleen might have suggested Gaucher's disease much sooner. This case demonstrates the value

of abdominal films in revealing an enlarged but not palpable spleen.

4. The diagnosis was uncertain until a bone biopsy was done, revealing the characteristic Gaucher cells.

5. Although the disease is usually familial, a careful examination of seven other members of this patient's immediate family revealed no evidence of the condition in any of them.

6. The most unusual features in this case are the cardiac enlargement and delayed A.V. conduction time, which we think could be due to Gaucher's cells in the myocardium.

Farmington, Maine

BIBLIOGRAPHY

1. THANNHAUSER, S. J., BENOTTI, J., AND REINSTEIN, H.: Studies on Animal Lipids; Determination of Lecithin, Cephalin, and Sphingomyelin in Body Fluids and Tissues. J. Biol. Chem. **129:** 709–716, August 1939.

2. RISEL, W.: Über die grosszellige Splenomegalie (typus Gaucher) und über das endotheliale Sarkom der Milz. Beitr. z. path. Anat. u. z. allg. Path. **46:** 241 1909.

3. af KLERCKER, K. O.: Beiträge zur Kenntnis des Morbus Gaucher, besonders in klinischer Hinsicht. Acta paediat. **6:** 302–351, 1927.

4. JUNGHAGEN, S.: Röntgenologische Skelettveränderungen bei Morbus Gaucher. Acta radiol. **5:** 506–516, 1926.

What Obligations Do We Have to the Radiologist Who Is Called Into the National Service?[1]

J. C. DICKINSON, M.D.

Tampa, Fla.

SINCE the subject of this discussion is in the form of a question, it may be well at the outset to formulate the principles that lead in my opinion to the answer. What obligations do we have to the radiologist who is called into the service? First, it is our obligation to see that he goes at the least possible sacrifice. Second, it is our obligation to keep his practice intact, in so far as possible, so that he will have something to which to return when his period of service is completed. Third and last, it is our obligation, not only in his interest but for the sake of our conscience as well, to make sure that his temporary withdrawal does not result in our financial profit.

Inevitably, my thoughts are largely influenced by the fact that my entire professional life has been spent in the private practice of medicine, approximately the last twenty-five years of it in the specialty of roentgenology. In consequence, my ideas on this subject apply primarily to the roentgenologists established in private practice who are called into active military service rather than to those just entering this specialty and those whose practice, wholly or in the main, is limited to institutional work. Too, I am seeing this problem from the standpoint of a physician who, because of age and certain other physical handicaps, will perhaps never be called for active service, and my thoughts have been directed accordingly.

The young physician who has completed his training but is not yet established in the practice of roentgenology may very well welcome the broad opportunity and wide experience that await him in the service of the armed forces of his country. Our obligation to him is not immediate. It need not be met until he has finished his period of service and is free to establish a place for himself among us.

The roentgenologist engaged in institutional work, supported and backed by a going institution, appears to be more favorably situated than his colleague in private practice. He will, of course, be called upon to make sacrifices, but it seems to me that the problems he faces are more easily solved than those of his fellow roentgenologist in private practice. In fact, the Board of Chancellors of the American College of Radiology, at its meeting last year in February, formulated a resolution (1) which, if followed in spirit, will probably as satisfactorily as possible take care of his situation. This resolution, concurred in in principle by the Board of Trustees of the American Hospital Association, provides that department heads called into service should be assured that their places will be open to them upon their return. It also provides that they should by choice be allowed to select an acceptable substitute. While not contained in the resolution, a further suggestion of the Board of Chancellors was that some arrangement be made whereby a part of the income of the department be placed in trust for the benefit of the member of its staff called into service. If the roentgenologist in institutional work can thus be assured that upon his return he may take up where he left off, and that during the period of his service his income will be amplified by the earnings of his department, to a large measure at least his financial sacrifice will be tolerable.

The roentgenologist in private practice, however, has certain well recognized

[1] Presented before the American College of Radiology at the Twelfth Annual Conference, meeting with Teachers of Clinical Radiology, Chicago, Ill., Feb. 15, 1942.

problems that his colleague in institutional work is spared and that are not encountered in other branches of medicine. The gross income of a well established radiologist in private practice may be substantial, but in most cases his net return is considerably less than that of physicians of comparable ability in other specialties. As a matter of necessity a large part of his income must be invested in physical equipment, which depreciates rapidly. Certainly the operating overhead is in the top bracket. The space occupancy is always high, for the very nature of his work requires a large floor space. His office, not laboratory (I hate the word), must be situated in a central location, where rents are above the average. Certain remodeling of the space required is necessary; plumbing, permanent power lines, and other installations must be made. If he decides to change his location, he cannot have the moving van come on Saturday afternoon and be ready to receive patients the following Monday. If, on going into the service, he is compelled to close his office, move and store his equipment, he is faced with a considerable amount of expense plus the fact that very likely upon his return desirable space will not be obtainable.

Another problem that faces the roentgenologist in private practice who is called into military service is the jeopardizing of certain well made plans for his security, as well as for the protection of those dependent upon him. In many instances this provision is represented by life-insurance plans, annuities, or some other form of long-term but regular investment. Unless these are to be sacrificed, some means of increasing his income during the period of service must be found.

While it is true that he has certain problems that are not common to the other members of the profession who are called into the service, it is also true that the very nature of the work makes it possible to carry on the practice of an absent colleague much more satisfactorily than can be done in any other field of medicine. This fortunate circumstance merely increases our obligation to carry on for him if we are willing to make the effort. I believe that the problem can be met best through the co-operation of those of us who are willing to see to it that his office is kept open and his business maintained as a going organization during his absence.

Most roentgenologists have a personnel that has been with them for a greater or less period of time since the establishment of their practice. Its members are well trained; they know office procedure; they are acquainted with the patients and the physicians who refer the patients. With a reasonable amount of supervision they can carry on a substantial part of the work, not ideally, it is true, and not as I think roentgenology should be practised, but even so in an acceptable manner. At this point I want to say that I feel we must all be prepared to accept the fact that we are not going to be able to carry on our practice "as usual" any more than we are going to have business "as usual." For the duration of this war both we, as physicians, and the public will have to accept the situation, and it will have to be the best practice we can carry on under the circumstances, and not the ideal, that must suffice.

In most instances, I feel sure, offices can be kept open and operated at a profit. In most communities, for various reasons, physicians refer the greater part of their work to some one roentgenologist. These practitioners should be interviewed by the roentgenologist called into the service as well as by the one who is to carry on the work. The plan should be explained to them, and they should be requested to continue the patronage of the office as in the past. They should be made to understand that upon their co-operation depends the success or failure of the plan. If a roentgenologist is willing to make the effort to preserve the practice of another at the expense of energy and time, though certainly not at the expense of his personal health, practice, or pocketbook, other members of the profession could hardly do

less than aid him in his endeavor. The physicians who refer patients would soon learn that they are being counted on not only to co-operate but also to appreciate that minute service and consultations need not be expected. I believe that in the vast majority of instances, if the matter is properly presented, wholehearted co operation will result.

The finances can be handled by the personnel of the office, under supervision. The reports can be made on the office stationery and signed by the roentgenologist doing the work as for the one in whose office the work is done. Thus the absent colleague is not forgotten; his identity as a roentgenologist of the community is maintained, and upon his return he will at the least have something left.

As to the last of the three premises, certainly the fact that our neighbor has been called into service should not result in our financial benefit. This war is a very personal affair and, as I see it, the obligation is just as great upon the man who for certain reasons is not eligible for military service as it is for the man in uniform. Because some of us are too old, crippled, or otherwise disqualified for service, that disability should not place us in a position of advantage that allows us to profit by it. It is too bad that profit cannot be forgotten for the duration of this trying period. I fully realize that such a thing is impossible; yet we certainly can see to it that we do not take advantage of our neighbor's absence to increase our personal gain.

I am aware that no one plan will work in every community. In each instance a plan should be worked out in a manner that gives full consideration to the local conditions. This presentation will, I trust, not be construed as an effort upon my part to submit an inflexible plan that I think should be universally adopted. I have tried to formulate principles rather than to recite details. A statement of policy made by this organization on this important matter will undoubtedly have a tremendous influence upon and be exceedingly helpful to many roentgenologists, both those going into the service and those who remain at home.

In working out the problem much is dependent upon the conditions that have previously existed. Was the former relationship one of co-operation? Has a good-neighbor attitude existed? Have the roentgenologists of the community realized that each can be the other's best friend, or have they had an attitude of childish petulance, finding fault and taking a dig at each other at every opportunity? Being co-operative does not mean any lack of competition. Indeed, keen competition and neighborly co-operation are thoroughly compatible.

I am fully prepared to hear the comment that these ideas are nice in theory, but impracticable, not workable. Someone will probably say that such a plan could be carried out for a short period of time, but what if the war lasts three years, five years, or longer? My answer is that under the present conditions no one can plan for the distant future; we will have to meet situations as they arise. The plan herein set forth is the plan to which I am committed. It is working in a number of places; it has been working for almost a year in our community, and it will continue to work for the duration of the war if everyone co-operates.

Citizens Building, Tampa, Fla.

REFERENCE

1. Bulletin of the Inter-Society Committee for Radiology: Preserving the Practice of Radiologists Called to Active Military Duty. Radiology **37:** 110, July 1941.

DISCUSSION

Mac F. Cahal (Chicago, Ill.): Dr. Dickinson not only represents the average private practitioner of radiology, but he has long occupied a prominent place in organized radiology. One point of immense importance which he mentioned in his address concerns the good will and *esprit de corps* existing among radiological colleagues in a community.

Common problems affecting the entire profession have brought doctors much closer together than they were a few years back, and radiology is no exception. Organization, local, state, and national,

has been recognized as essential if common problems are to be solved and the welfare of the individual practitioner is to be protected. A new and vital responsibility is now placed upon these organizations in connection with the dual war we are waging to defeat the forces of evil abroad and to protect the American ideal at home.

Besides the obligation mentioned by Dr. Dickinson to protect the interests of the man who leaves his private practice to serve in the armed forces of his country, we owe another, and perhaps a greater, obligation. We have an obligation to make it easy for a radiologist to leave his private practice and thus make himself available to the Army or Navy. We should encourage our members, wherever possible, to volunteer for commissions, because, as you all know, the need for doctors, and especially radiologists, is acute. By meeting the first obligation we shall have gone far toward meeting the second. It is obvious that men will be much more willing to apply for commissions if some method is worked out whereby their practices can be kept intact for them and their financial sacrifices minimized. In one we benefit the individual; in the other the nation.

In approaching the problem there are two situations to be considered. There are the problem of the radiologist's practice in a private office and the problem of his position on a hospital staff. Inasmuch as 97 per cent of all radiologists are members of one or more hospital staffs, and 77 per cent maintain private offices outside the hospital, it appears that the two situations are of equal importance.

Before considering these two situations further, we should perhaps mention briefly some general provisions of the law which can be invoked by a radiologist during his period of military service. By provision of the Soldiers' and Sailors' Relief Act of 1940, a man serving in the Army or Navy is given certain specified rights of protection. His family cannot be evicted from a private dwelling where the rent does not exceed $80 per month except by order of court. If he is purchasing equipment or other property on an installment basis or is obligated on a mortgage, the seller cannot terminate the contract or regain possession upon default except by order of a court. He may retain $5,000 worth of life insurance without payment of premiums during the period of his military service and for one year thereafter. It is obvious that only a small portion of the total insurance carried by most doctors would be thus protected under the Act. Certain dispensations in the payment of income, personal property, and real estate taxes are also provided for in the Act.

There is another right conferred by the law which should be considered in discussing the personal sacrifices faced by a radiologist entering the Army or Navy. That is the pay authorized for officers. A First Lieutenant in the Army, or a Lieutenant-Junior Grade in the Navy, with dependents, is allowed pay of $3,152 per year. A Captain or a Lieutenant-Senior Grade gets $3,792. A Major or Lieutenant Commander draws $4,848. A Lieutenant Colonel or a Commander in the Navy receives $5,588. And a Colonel in the Army or a Captain in the Navy is paid $5,872. It is apparent that the actual financial sacrifice in any instance will vary somewhat according to the commission received upon induction. The difference is more apparent than real, however, in view of the obvious fact that an older man who receives a higher commission is likely to have more personal obligations than a younger man. Also, in most cases the older man will be leaving a more lucrative practice and one of longer standing.

Now let us consider the problem of a radiologist's hospital appointment when he leaves civil life to serve in the armed forces of his country. The radiologist in most instances has either a written or an oral contract with his hospital. It should be clearly understood in the beginning that, if he voluntarily ceases performance by enlisting in the Army or Navy, the hospital is under no legal obligation to keep his position open. In the eyes of the law he has committed a breach and the hospital is legally entitled to terminate the contract and replace him. On the other hand, everyone will agree, I think, that the hospital has a high moral duty to protect him to the fullest extent possible. As a matter of fact, if the radiologist is drafted, the hospital is under a legal obligation to do so. The Selective Service Act requires it to grant a leave of absence and reinstate an employee, with the same status and the same financial arrangement, for a period of at least one year following his return.

It is unfortunate that a man who volunteers is not entitled to have his position left open for him, while a man who waits to be drafted is assured this protection. But, according to my understanding, this is the situation and it adds to the moral obligation imposed on the hospital. The fact is, of course, that few radiologists will be drafted. Most of them eligible for service will have applied for commissions before being called.

A year ago the Board of Chancellors of the College adopted a resolution recommending that a radiologist entering military service be given the privilege of selecting his substitute for a hospital position and entering into an ordinary *locum tenens* contract that, in some instances, would give the absentee a portion of the net income from the hospital practice. Here again we must substitute moral obligation for legal principles, since a contract for personal services is not delegable, and the hospital is under no legal duty to accept a substitute in the place of a radiologist with whom it has a contract. I think most hospitals, as a patriotic gesture in the national emergency, will agree to accept the substitute and permit the radiologist to make whatever financial arrangement he wishes with him.

The fact is that the American Hospital Association a year ago adopted a resolution recommending to all hospitals that, "consistent with local conditions, leaves of absence be granted to all employees during the period of their active military service." While directors of hospital radiological departments are not employees of the hospital, and while we do not like to refer to them in these terms, we are nevertheless assured by the American Hospital Association that the resolution is intended to include radiologists with whom hospitals may have contractual agreements.

That this recommendation has not been consistently followed by all hospitals is evidenced by the fact that we have already received at the headquarters office several complaints citing instances in which a hospital has summarily replaced a radiologist called to military service by entering into a permanent contract with another man. In other instances, a hospital has bid its radiologist Godspeed with the assurance that it would be glad to enter into negotiations for a new contract upon his return from the war. The probabilities are that there will be a great many more radiologists at the close of this war, as was the case following the last war, and it is not unlikely that a radiologist will have somewhat greater difficulty in obtaining an ethical contract with his hospital when it sees the opportunity of making a handsome profit from the radiological department by employing one of the less competent men who will be available.

I have suggested to the Board of Chancellors that the Councilors of the College be asked to appoint a committee in each state which should serve for the duration in a effort to work out these problems. Circumstances will naturally vary in every community and with each institution. Nevertheless, active intervention on the part of a permanent committee, which in turn would enroll the support of county and state medical societies, should go far toward protecting the radiologist and at the same time assure the best quality of radiological service for the civilian population. The Chicago Roentgen Society has already taken action in this regard and Dr. Willy will describe to you the sound program which this Society has worked out.

The private office, to my mind, presents a less difficult problem than the hospital appointment. In some cases the radiologist entering service will be able to obtain a *locum tenens*, and the College has worked out a model contract to assist in drawing up the agreement between them. In other cases, his colleagues, out of the goodness of their hearts and the dignity of their profession, will make their patriotic contribution by arranging to keep his practice intact during his absence and give him a fair portion of the net income. The number of unattached radiologists available for *locum tenens* positions will naturally be reduced as more and more men leave private practice for the Medical Corps, and the plan outlined by Dr. Dickinson will in most cases be the only alternative. In many respects it may be the better. I hope that each regional and state radiological society will set up a plan modelled along that described by Dr. Dickinson and ask each radiologist in the community to sign a pledge to serve in any manner he is called upon to protect the financial interest of a colleague who offers his services to his country. This war is going to require sacrifices of all, and it should be the responsibility of organized radiology to equalize the sacrifice between those going to war and those staying at home.

The American College of Radiology will call upon its state Councilors and all regional societies to join it in meeting this new and vitally important responsibility. The responsibility is three-fold: (1) We must encourage our members to volunteer in the Army and Navy. (2) To do so, we must protect their interests while they are away. (3) In doing so, we must resolve to maintain for the civilian population the highest quality of radiological service that is possible under the conditions.

Ralph G. Willy, M.D. (Chicago, Ill.): Our plan is briefly explained. It is, I am sure, one that has been adopted by many societies. We have a four-point program: (1) To encourage members to enter the armed forces. (2) To insure a good radiological service to the public and to the hospitals. (3) To maintain the offices and appointments of the men who are called into service. (4) To see that the men who go into service are not suffering too much financial loss thereby.

This plan was adopted and explained to the Society in open meeting and a questionnaire was sent to the members, stating the principles involved and asking if they were willing to help; if so, how much time they could give, when such time could be given, and in what part of the city. This questionnaire met with a wonderful response. In accordance with the replies we have listed all the men, with details of the time available and the location where they can best serve. We have not yet been called upon to do much, but hope we shall be. How the plan works can be told better after a year's time.

We have felt that it is largely a matter of education—and one which the radiologist can himself direct—to prepare the hospital superintendent and staff to accept a service which, while it is adequate, may not be wholly up to former standards, for in our city, at least, when a radiologist leaves an institution there is just no one available to take over his appointment on full time.

So far the hospital superintendents have, as a rule, fallen in with our plan. Whether they will continue to do so we cannot tell, but if we stick together I believe we shall be successful, for we are in complete control of the situation.

Q. B. Coray, M.D. (Salt Lake City, Utah): All the speakers thus far have discussed this problem from the standpoint of principles. It may be of

interest to outline the agreement reached by the three radiologists in Salt Lake City. The three of us are Diplomates of the Board. We have a gentlemen's agreement not to accept appointment on a hospital staff to replace any man who is called into the service. We have agreed, also, that we will keep all our offices open and the man who is called into the service can call on either one or the other of the remaining two men to go to his office and to the hospitals and do the work there. The reports will go out from the office of the man who is in service just the same as if he were there.

All the finances will be handled from the office of the man who is in the service. The office and hospital overhead expenses will be deducted and from the net returns he will receive half and the man who is taking hold of the job for him will receive the other half.

J. C. Dickinson, M.D. (*closing*): I appreciate very much the discussion that my presentation has stimulated. One point which was emphasized was our obligation to encourage men to go into the service. I know of no more tangible encouragement that one can give than to assure a man that those of us who stay at home are going to do the very best we can to protect his interests while he is gone.

As to the hospitals, it seemed to me that the Board of Chancellors did pretty well last year when they obtained the agreement of governing bodies of the American Hospital Association, in principle, to the resolution which they presented. If they cannot hold their members in line it is unfortunate.

It has been suggested that the Board of Chancellors ask the Councilor for each state to formulate a plan for use in that state. I think it will be helpful if the Board at this meeting will draw up a definite plan which may be submitted to the Councilors as a pattern. Nothing that I know of so helps a local man in presenting a situation to his own hospital, or to some other hospital, than to be able to say: "This is the action of the national body. This isn't my plan. It's the thing that is being requested all over the country."

So far as those persons are concerned who accept appointments and take advantage of the absence of a man in the service of the country, I believe that in most instances there will be some way of dealing with them before it is too late.

One point which I think we must keep before us in trying to put across any plan is simply: "Is it right?" Having answered this in the affirmative, we can go ahead and sell it to the rest of the profession in the community. If the Staffs of the institutions with which we are connected approve of the things we are trying to do, they can do much toward seeing Boards of Directors and others and obtaining a favorable response.

Requirements for Roentgenological Services in the Field of Combat[1]

ALFRED A. DE LORIMIER, M.D.

Major, Medical Corps, U. S. Army; Director, Department of Roentgenology, Army Medical School

THE SPIRIT of co-operation and the patriotic interests which have repeatedly been manifested by the American College of Radiology and representative societies of our specialty are deeply appreciated by the Office of the Surgeon General of the Army. I sincerely respect the privilege of expressing this appreciation. In the present paper it is my intention to present generalities relative to the responsibilities of the roentgenologist in assisting the combatant forces, and at the same time to solicit ideas as to qualification requirements and the most practical means of providing emergency or additional instruction.

Our Army has need for more roentgenologists, a need which appears to be in excess of the number now recognized as qualified and available. This situation may be explained, no doubt, by the fact that, when medical and surgical services must be accomplished under such conditions of stress as characterize activities in the combat zone, the roentgenologist must assume, in addition to strictly roentgenological duties, a large measure of the diagnostic responsibilities which are ordinarily handled by the general practitioner, the internist, and other specialists. It can be expected that, during combat, casualties will be received in large numbers and diagnoses must be made within a minimum of time. This can be accomplished most expeditiously by exercising judgment with the assistance of the most trustworthy of our special senses —the visual sense. That which cannot be seen by external viewing will be sought by roentgen study. This would seem to be true to an extent even greater than during the first World War, for today, in addition to general fluoroscopic procedures for study of the skeleton, x-ray examinations are accepted as the most reliable means of diagnosing abnormalities in the abdomen, the chest, and the skull. True enough, localization of foreign bodies may not be required as frequently as during the last World War. The science of ballistics has so changed that today missiles have greater penetrating characteristics and many cases, we understand, will be handled immediately by surgical débridement, chemotherapy, and closure without roentgenologic assistance. Nevertheless, a considerable demand for fluoroscopy is to be expected, and there can be no doubt but that there will be some foreign body localization. A single case of this sort, such as is familiar to all of you in your practice, will emphasize the fallacies of a policy whereby surgery would be initiated without roentgenologic assistance. This case, with pertinent details, is shown in Figure 1.

It appears that our specialty will be utilized to an extent proportionately greater than is required for general civilian care. For this reason it would seem that for the present emergency there has been a disproportion in the development of radiologists as compared with other specialties. We face a shortage, therefore, which must be met by special training. For certain assignments, it would seem that this training need not be as complete as that which is considered essential for a well rounded roentgenologist; not sufficiently complete, for instance, to meet the qualifications required by the American Board of Radiology. Still, certain fundamentals must be understood. What may these be?

The answer to this question must be based upon a consideration of the activities to be expected of a roentgenologist in one or another medical installation. Because of the character of present-day warfare,

[1] Presented at the 12th Annual Conference of the American College of Radiology, meeting with Clinical Teachers of Radiology, Chicago, Ill., Feb. 15, 1942.

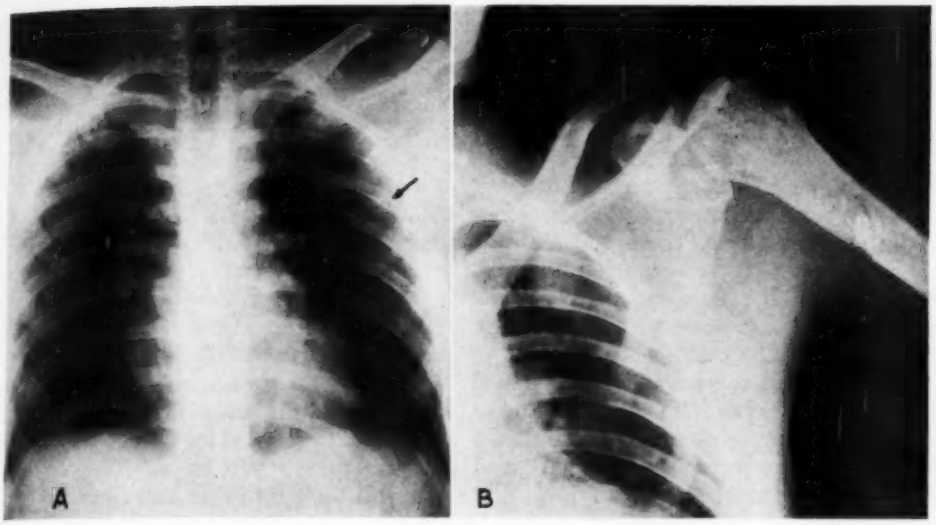


Fig. 1. This patient was shot in the chest. A wound of entrance was noted in the left upper thorax. This site was identified roentgenologically because of the powder markings (see arrow in A). The clinician was interested in the location of the bullet and when it was reported that none was demonstrable within the thorax, he was greatly surprised. No wound of exit could be found and therefore further roentgenographic studies were requested. It was then found that the bullet had been deflected from a rib surface into the left axilla, finally to become embedded in the left humerus (B).

Analysis of this case required a considerable period of time—more time than would have been required had the roentgenoscopist been recognized as the diagnostician.

however—the rapidity of movement and the frequent change in the battle front with alternations of offensive and defensive tactics—medical installations can be considered merely in a relative manner. We cannot think of well identified and established situations. The surgical hospital of today may serve as an evacuation hospital tomorrow, and within a few days may become a general hospital—or *vice versa*. For purposes of orientation, nevertheless, we may speak of a type arrangement.

It may be recalled that in the U. S. Army it has not been found practical to provide for roentgenologic assistance with the attached medical troops of the front-line forces nor to assign such services directly with the medical battalion (*i.e.*, medical regiment of the first World War). Roentgenologic units are not constituents of the division. It is believed that the furthest forward medical installation at which roentgenologic assistance can be utilized effectively is the surgical hospital. This is an Army unit which moves forward to the vicinity of the clearing station (of the medical battalion) as casualties accumulate there. Its purpose is to provide the first real surgical care for those of the wounded who, because of their condition, cannot be evacuated further to the rear—to the evacuation hospital. Prior to this care, treatment will have consisted merely of first-aid dressings or perhaps the application of a tourniquet. At the surgical hospital, any type of emergency surgery may be performed, though all procedures must be accomplished quickly. Usually, the casualties reach this station within four to fifteen hours and should be transported further to the rear as soon as possible—probably within one to three or four days.

The surgical hospital consists of a "hospitalization unit" and a "mobile surgical unit." The hospitalization unit includes two to four tents, each accommodating 100 cots, thus providing a total accommodation for as many as 400 patients. The mobile surgical unit consists of a "corridor tent" and equipment for two sur-

gical teams, a splint team, a shock team, a plastic maxillo-facial team, and a roentgenologist (having rank of a lieutenant). These groups are expected to handle as many as eighty major surgical procedures each twenty-four hours. A second roentgenologist (perhaps a captain) is assigned to the hospitalization unit. Thus, according to present plans, there will be two roentgenologists at the surgical hospital, to be assisted by three x-ray technicians (a staff sergeant and two fourth-class privates). During periods of considerable activity, both of the roentgenologists will doubtless be engaged in fluoroscopy. Some of this work may be accomplished within a closed truck but certainly some of it, and in many of the installations all of it, will be accomplished in fluoroscopic tents.[2]

The operating section of the surgical hospital is especially mobile and self-contained. After meeting the needs in one location where casualties have accumulated, it can move on to another location where others have collected or it may function with an evacuation hospital or any other medical aggregation. One of the two roentgenologists moves on with the operating unit (the lieutenant), while the other (the captain) remains with the hospitalization unit, which is left behind. The latter is equipped with a fluoroscopic tent, an x-ray machine unit, and a field table unit. No doubt some further fluoroscopy may be required, or possibly roentgen therapy for the treatment of infections. The roentgenologist accompanying the operating unit will for the most part confine his activities to general fluoroscopy and foreign body localizations. These activities must be taken into consideration when we discuss the training requirements for these assignments.

The evacuation hospital will ordinarily accommodate more patients than the mobile surgical hospital. Usually, it will be located close to transportation facilities —perhaps in a schoolhouse, theatre, or church, though it may consist of tents. To it, equipment has been allotted for handling as many as 750 patients. In most instances, it will be 30 to 70 miles to the rear of the front line, but even so, expeditious handling of the casualties is essential. Two roentgenologists (a captain and a lieutenant) have been allotted for this installation, with as many as ten x-ray technicians (three staff sergeants and seven privates). The services here will be mostly fluoroscopic—just as at the mobile surgical hospital. Occasionally, perhaps in 10 per cent of the studies, roentgenography may be practical. In addition, therefore, to the equipment provided for the mobile surgical hospital, there will be at the evacuation hospital some films, a film processing unit, and a film dryer unit. The dark room tent such as is used for fluoroscopic purposes at the surgical hospital can be adapted for film processing, and several of these will be supplied. Thus, the roentgenologists at the evacuation hospital must be competent to handle general fluoroscopic procedures, foreign body localizations, diagnostic roentgenology, and superficial roentgen therapy.

It is realized that in both the surgical hospital and in the evacuation hospital, quick judgments must be rendered. The roentgenologists must possess self-reliance and resourcefulness.

A convalescent hospital may be set up near an evacuation hospital. This may have accommodation for as many as 3,000 patients. Active studies here, however, should not be as numerous as in the surgical hospital or the evacuation hospital and therefore only one roentgenologist and five technicians have been allotted to this installation. The roentgenologist may have the rank of captain. Since this hospital will serve to accommodate overflow from the evacuation hospital and since it will be located close to that installation, the assistance of the senior roentgenologist of the latter hospital may be utilized for serious problems.

The next echelon concerned with the handling of battle casualties will ordinarily be the general hospital. While treatment

[2] For a description of the fluoroscopic tent and illustrations see the author's paper in Radiology 36: 391–403, April 1941.

range at the mobile surgical hospital may be one or two days, and at the evacuation hospital three or four days or a week, more definitive handling can ordinarily be expected at the general hospital. The general hospital is therefore more completely equipped. As far as x-ray apparatus is concerned, there will be four to eight portable and mobile units and one or two high-milliamperage-capacity machine units (1 2-

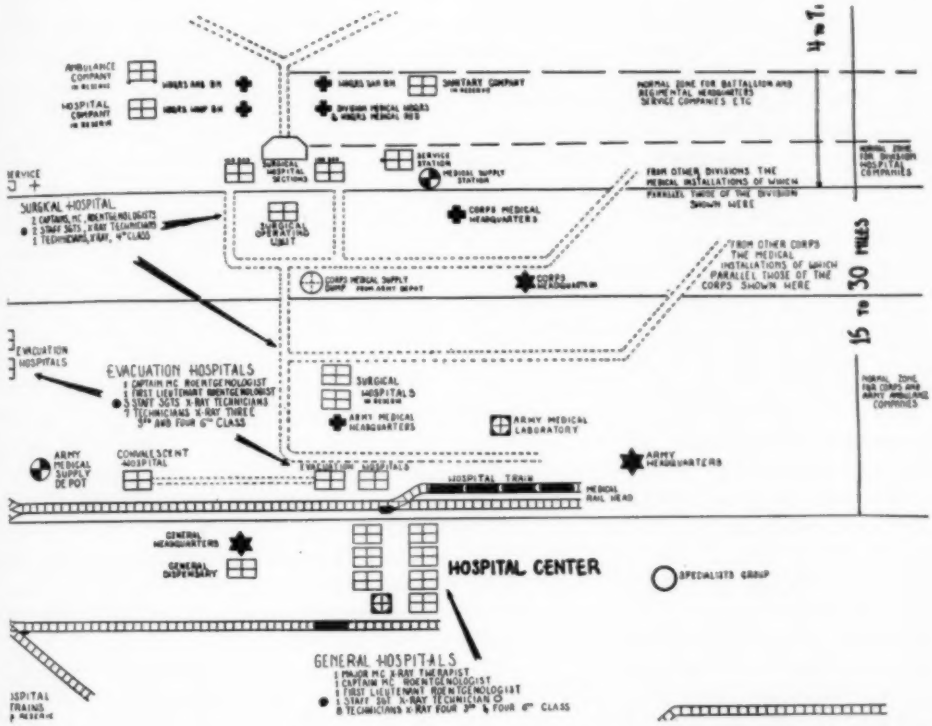


Fig. 2. Relative positions of the three important installations in the theatre of operations requiring roentgenologic services.

tube/200 ma. unit and 1 1-tube/200 ma. unit) complete with tables. Various auxiliary items will be provided. One thousand patients can be accommodated and for each one thousand patients, three roentgenologists and nine x-ray technicians have been allotted. Their services may be of a versatile character—practically any service required in a well recognized hospital. At least two of these roentgenologists must be well qualified; it would seem to me that for an isolated general hospital, both should be able to meet the requirements of the American Board of Radiology. In case of an aggregation of general hospitals, with a bed census in excess of one thousand, there would be developed a hospital center. Additional radiologists would then be available. It would seem that some of these might be assigned limited activities, much as in the case of fellows in radiology in teaching institutions, so that not all of them need possess the range of qualifications required by the Board.

Station hospitals should be mentioned. These serve "combatant forces not actually engaged." To those having a bed capacity in excess of 250, a roentgenologist may be assigned. His activities would be of a diverse character. For a medium-sized (500 beds) or larger installation, a well qualified

roentgenologist having a rank of captain or major would be provided.

The next question might be: What is the approximate number of each of these types of hospital installation? Perhaps some of you are acquainted with percentage considerations. You may have heard that accommodations of "fixed beds" (at general hospitals and station hospitals, but not including mobile surgical hospitals or evacuation hospitals) are estimated on the basis of 10 to 15 per cent of the strength in the combat zone. You probably know that in the theatre of operations allotment of Medical Department troops is calculated as 10 per cent of the numerical strength of the field force, and perhaps you realize that ordinarily 13 or 14 of each thousand of these would be x-ray technicians. In a similar manner, estimates as to the need of roentgenologists might be figured. However, because of the fact that for this *worldwide* war our forces must be so greatly distributed, it has not been believed practical to follow these percentage calculations. Instead, estimates of professional needs have been based upon "sampling"—indications as to needs for isolated stations, closely communicating stations, and installations of varied sorts such as armored units, coast artillery units, air corps, etc. On the basis of this study, it is estimated that for an active Army of 3,600,000, there will be needed approximately 6,000 x-ray technicians.

I have not been able to learn the actual number of qualified x-ray technicians now in the Service. I am told, however, by the Office of the Surgeon General, that considering technicians now available and our training facilities within the Army, our needs can be met. Today, two- and three-month courses in roentgenography are being given at six locations, the Army Medical Center (having a quota of 40 per month); Fort Sam Houston (having a quota of 15 per month); Fitzsimons General Hospital (having a quota of 15 per month); William Beaumont General Hospital (having a quota of 15 per month); The Army and Navy General Hospital (having a quota of 10 per month), and the Letterman General Hospital (having a quota of 6 per month). Provision is thus made for the production of x-ray technicians at the rate of 101 per month. Accommodations are being increased and it is estimated that our Army courses together with enlistments and draftings of qualified technicians will account for increments of approximately 1,500 x-ray technicians annually.

Formerly our course at the Army Medical School was recognized by the National Registry of X-ray Technicians. Very recently, this recognition has been withdrawn. We have no criticism of this decision. We realize that today our training must be hurried and of a didactic character; it is not possible to develop fully competent technicians having a range of practical experience and for this reason the roentgenologist must possess fundamental knowledge. He may have to utilize the services of stranger technicians. He may develop a good one only to lose him, either because of his own transfer or transfer of the technician. Thus, he must conduct close supervision and actual training in order to provide himself with suitable assistance.

The following is an estimate as to needs of roentgenologists for our Army of 3,600,000, based upon sampling such as described above:

Hospital Installation	Estimate of Number	Roentgenologists Required	Estimate as to Need of Well Qualified Roentgenologists
General hospitals	225 (numbered)	675	350
	22 (named)	66	22
Evacuation hospitals	45	90	45
Surgical hospitals	15	30	15
Station hospitals	129	129	65
Convalescent hospitals	3	3	3

According to these estimates for a numerical strength of 3,600,000, it would seem that the Army has need for approxi-

mately 1,000 roentgenologists. Of these, we believe that approximately 500 should be comprehensively trained. These estimates do not include the needs of examination centers. For the latter, an additional 100 might be considered. Officially the estimated total need is 1,047.

The Office of the Surgeon General is making every effort to identify all specialists and to assign such men in accordance with their particular qualifications. It can be said that any deviations from this policy occur secondarily, following assignment of the individual to an administrative unit.

The bulk of roentgenologic needs is being provided by services of already qualified roentgenologists—doctors coming into the Service or those already in the Service, who have had extensive experience in this specialty.

Auxiliary instruction of officers in roentgenology is being provided at the Army Medical School in Washington, D. C. Two courses are now being conducted, in alternate months. The shorter of these deals with the special examinations conducted at induction centers. It is intended for qualified roentgenologists and deals entirely with the particular applications of the specialty with respect to photoroentgenology and the stipulations provided by our regulations. This course is limited to two weeks.

Much more important for our consideration at this time would seem to be the matter of emergency training for those 500 who, it is believed, need not have such a wide range of roentgenologic knowledge or experience but whose duties would be important as assistants in the actual theatre of operations. At the present time, it is our opinion that most of this training can be accomplished within the Army itself, though it may be found, before long, that some of it will have to be given in other teaching centers. The schedule which is being followed for our Intensive Basic Course in Roentgenology is reproduced here.

It will be noted that this course consists of: didactic lectures, for 133 hours over a period of four weeks; conferences, 12 hours; special problem investigations, 44 hours; examination periods, 3 hours. In this way, eight hours a day for six days a week—a total of 192 hours—are applied to this course. It will be noted that no time is allotted to positioning or actual roentgenography. These phases of the subject are covered by a Technical Manual—TM 8-240. Six hours are allotted to identification of controls for both mobile units and stationary units. Seven types of controls are utilized and the presentations are by way of initiating answers by the officer rather than by abstract descriptions of the equipment. Every phase of instruction is presented with demonstrations, and throughout the course attentiveness is enforced by interval questioning. For the diagnostic sections, general procedures are described and demonstrated and roentgenographic studies are presented by lantern slides. Direct and indirect evidence is described by way of roentgen criteria. It is strongly emphasized that the analysis of the roentgenologist should be based upon: first, an orderly study of the film evidence and a listing of roentgenologic criteria; second, a consideration as to what collaborative evidence might be gained by obtaining roentgenographic studies of portions of the body other than that under primary investigation; third, a consideration of such factors as the age of the patient, sex, nationality and race, occupation, etc., in relation to the general incidence of the suspected condition; fourth, the history; fifth, the physical findings; sixth, the laboratory findings. It is repeatedly emphasized that the roentgenologist is a consultant and as such he must not limit his considerations to a picture. He must be an investigative scientist.

In summarizing these aspects, may I repeat the two basic thoughts:

(1) The Army needs more roentgenologists; it needs them urgently; it needs them, now. Where instruction requirements are indicated, the course must be

INTENSIVE BASIC COURSE IN ROENTGENOLOGY

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			FIRST WEEK			
A.M. 8–9	Outline of course Plan of special problems	Special problems	Special problems	Special problems	Special problems	Special problems
9–10	Roentgenology Roentgen physics Roentgenography Roentgen diagnosis Roentgen therapy	Special problems	Special problems	Special problems	Special problems	Special problems
10–11	Radium Radium physics Radium therapy	Rheostats Solenoids Choke coils	Rectification Mechanical Thermionic Inverse suppressors	Mobile units	Technical factors (Ma., Kv.P., T. and D.)	Processing chemicals
11–12	Nature and origin of x-rays	Transformer Step-up Step-down	Detailed wiring diagrams	Line requirements	Physiology and treatment of electrical shock	Film processing testings
P.M. 1–2	The Electron Static Chemical thermo Piezo imbalances	Auto-transformers Volt selectors Line compensators	Dissected stationary units	Handling of controls, stationary units	Films Cardboard holders Cassettes	Examination
2–3	Magnetism Terrestrial Natural Artificial Electro-	Measuring instruments	Handling of controls, mobile	Stationary units	Film handling Captioning Filing	Conference W.R.G.H.
3–4	Electric currents Units of electricity	X-ray tubes Filament Circuits	Military courtesies Customs of the service	Facilities of a post chaplain's duties	Organization Medical Service Surgical Service	Conference W.R.G.H.
4–5	Dynamos Motors	Simple wiring diagrams	Mobile units	Stationary units	Dark room construction features	Conference W.R.G.H.
			SECOND WEEK			
A.M. 8–9	Special problems	Special problems	Special problems	Special problems	Special problems	Special problems
9–10	Special problems	Special problems	Special problems	Special problems	Special problems	Special problems
10–11	Roentgenographic quality Distortion	Photoroentgenography The camera	Stereoscopy	Fractures of extremities	Tumors of bone	Arthritic lesions
11–12	Detail	Layout of examining center	Caliper technic	Bone infections (extremities)	Metabolic bone diseases	Arthritic lesions
P.M. 1–2	Contrast	Single emulsion film	Kilovoltage variations	Bone infections (extremities)	Metabolic bone diseases	Film interpretation
2–3	Secondary radiation Diaphragms Cones Grids	High kilovoltage chest technic	Roentgen diagnosis: normal bones	Tumors of bone	Lesions of the joints: classification	Conference W.R.G.H.
3–4	Density	The processing of men	Organization of N. P. Section laboratory service	Medical supplies	Efficiency reports Leaves	Conference W.R.G.H.
4–5	Common film errors	Preservation of films	Anomalies in the extremities	Tumors of bone	Arthritic lesions	Conference W.R.G.H.

concise—much shorter than that usually required for fellows in roentgenology at teaching institutions.

(2) To meet this emergency need the present policy is to utilize the services of those already qualified, to the best advantage—*i.e.*, by assignments to their specialty; to complement these services by

INTENSIVE BASIC COURSE IN ROENTGENOLOGY—*continued*

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			THIRD WEEK			
A.M. 8–9	Special problems	Special problems	Special problems	Special problems	Special problems	Special problems
9–10	Special problems	Special problems	Special problems	Special problems	Special problems	Special problems
10–11	Non-arthritic lesions of joints	Spondylitis	The skull: blastic lesions	Fractures Infections of paranasal sinuses	Thoracic cage and pleurae	Induction Board examinations
11–12	Non-arthritic lesions of joints	Tumors in and about the spine	The skull: intracranial lesions	Neoplasms of paranasal sinuses	Mediastinum	Photoroentgenology: cardiac configurations
P.M. 1–2	Non-arthritic lesions of joints	Film interpretation	Facial - maxillary conditions: general	Film interpretation	Lung fields	Examination
2–3	Film interpretation	Film interpretation	Facial - maxillary fractures and infections	Fluoroscopy	Heart: generalities	Conference W.R.G.H.
3–4	Film interpretation	The skull: general considerations	Facial - maxillary neoplasms	Radiation incurred during fluoroscopy	Cardiac mensuration	Conference W.R.G.H.
4–5	The spine: development and anomalies	The skull: lytic lesions	Paranasal sinuses and mastoids: general	The thorax: general	Heart: abnormalities of configuration	Conference W.R.G.H.
			FOURTH WEEK			
A.M. 8–9	Special problems	Special problems	Special problems	Special problems	Special problems	Roentgenological activities in the theatre of operations
9–10	Special problems	Special problems	Special problems	Special problems	Special problems	Roentgenological activities in the theatre of operations
10–11	Photoroentgenology	Gastro-intestinal pathology: the esophagus	Lesions of the colon	Lesions of the ureter and bladder	Treatment of deep-seated neoplasm	Field x-ray equipment
11–12	Photoroentgenology	The stomach	General abdominal studies	Intravenous studies	Property: requisitioning of, and responsibilities for	Foreign body localization
P.M. 1–2	Diseases of gallbladder, etc.	The small intestine	Spinography	Studies of the pelvis	Administration of an x-ray department	Presentations Special problems
2–3	Diseases of gallbladder, etc.	Barium enemas: general	Planigraphy	Roentgen therapy: generalities	Field x-ray equipment	Presentations Special problems
3–4	Gastro-intestinal series: general	Fluoroscopy	Genito-urinary studies: general	Treatment of dermatosis	Written examination	Presentations Special problems
4–5	Fluoroscopy	Lesions of the colon	Lesions of the kidney	Treatment of superficial neoplasm	Written examination	Graduation

the services of doctors who may not have a fully adequate background but who have manifested an inclination toward radiology and who might be guided by a four weeks' didactic lecture course and subsequent supervision. These latter might be considered as comparable to fellows in a radiological department.

Army Medical School, Washington, D. C.

DISCUSSION

W. Edward Chamberlain, M.D. (Philadelphia): I was under the impression that a fairly well qualified

roentgenologist would be required at the station hospital, especially as he would be by himself. It is here that epidemic diseases are likely to be picked up, as, for example, pneumonia.

Major de Lorimier: That is quite true, and has been taken into consideration. For a station hospital of 500 to 750 beds—and some have as many as 1,000 beds—the roentgenologist may have the rank of Major. But it is to be borne in mind that many station hospitals are much smaller—250, 150, 50, or even 25 beds—and to these no roentgenologist is allotted.

Arthur C. Christie (Washington, D. C.): I believe we would all like to know how much training these men should have after they complete the basic course which Major de Lorimier has outlined. Undoubtedly most of the men who are taking this course have had some radiological experience and may not require much additional training. It seems to me, however, important that we should know just about how far to undertake to train those men who go through the Army course with little preceding basic experience and how long a period will be required for such training.

Major de Lorimier: That is a question that I hoped might be answered by someone else. It is the present policy of the Training Division of the Office of the Surgeon General to limit the courses given by the Army Medical College to one month. (Some technicality with which I am not familiar seems to enter into this question.) I understand, however, that efforts are being made to change this.

Those who are enrolled for this intensive course are doctors who have had x-ray equipment in their offices, who, for example, have been assigned to a small station hospital and, feeling the need for further training, have requested such a course as this. None of this group has had a fellowship in radiology. The officers who have come to us for courses in photoroentgenology have for the most part held fellowships and are therefore well trained. As regards these auxiliary trainees there seems to be no formulated plan beyond that which I have mentioned.

Maintaining the Supply of Specialists During the National Emergency[1]

B. R. KIRKLIN, M.D.

Secretary, American Board of Radiology, Rochester, Minn.

IN THE PRESENT tremendous national emergency, we of the Advisory Board for Medical Specialties are keenly conscious of expanded responsibilities and opportunities for service. First among our duties, of course, is that of serving the military forces of our country. Second, and scarcely less imperative, is our obligation to serve the civilian population. In the third place, there rests on us the responsibility of maintaining continuity of these services by educating and training our successors, in adequate number and ability, year by year, until and after the emergency has passed. Obviously, the degree of emphasis that should be placed on each of these functions is bound to vary with time and circumstance, but they are interactive and mutually supportive, and none can safely be ignored.

Until recently any medical student whose work was satisfactory was, if it were so recommended by the dean of his medical school, deferred by the local draft board until he had completed his medical course and served an internship for at least one year. Furthermore, many draft boards permitted some of these young men to complete all or a substantial portion of a three-year graduate course in their chosen specialty. All this has been changed, however, since the meeting of the Association of American Medical Colleges. The medical schools now decline to recommend deferment of a medical student by a local draft board unless, and until, he has been refused a commission in the reserve corps of the Army or Navy. As a large majority of recent graduates are physically fit, they are accepted for commissions and thus their opportunity for graduate training is controlled by the Surgeon General of the Army or of the Navy. It is understood, however, that they will not be called to active duty until they have served an internship of at least one year.

If these men are called to duty as soon as they have completed their internship, the ranks of the specialists will be depleted progressively and rapidly. Soon the expanding medical services of the Army and Navy will be unable to obtain needed specialists. Medical service to the public by independent practitioners will deteriorate because competent consulting specialists will steadily become fewer. A scarcity of graduate students in hospitals, medical schools, and other institutions where prospective specialists are trained, and where they perform certain essential routine duties during the period of training, will be detrimental to the interests of the public served by these institutions.

This is the situation that confronts the medical profession. At this time, and properly so, the emphasis is on medical service to the Army and Navy. Other medical activities must make adjustments and sacrifices. But all may hope and reasonably expect that these sacrifices will be determined and imposed with wisdom, fairness, and foresight.

As members of the Advisory Board for Medical Specialties, we are deeply interested in any necessary adjustments in the education of specialists, and if we can offer any helpful suggestions they probably will be given due consideration. Among measures proposed or contemplated, that of obtaining permission from the Surgeons General for some of the more promising students to take at least partial training in their chosen specialties appeals strongly to me. Such students should be selected solely on the basis of their merits; those who have shown especial promise during

[1] Read before the Advisory Board for Medical Specialties, Chicago, February 15, 1942.

their medical course and internship and who have supporting recommendations from their hospital and medical school should be permitted, or even encouraged, to apply for residencies or fellowships in their chosen specialties. These are essentially the students now selected for graduate training by most of the institutions which are approved by the Specialty Boards and the Council on Medical Education and Hospitals of the American Medical Association. If at any time during the graduate student's course of instruction he becomes lax or indifferent in his work, this fact should be reported to the Surgeon General of the service in which he is enrolled, or, if more desirable, each institution could make periodic reports to the two Surgeons General, indicating the character of work being done by the men who are under their respective jurisdictions. This plan would be fairer than was that of leaving the matter to the judgment of local draft boards, no two of which may have the same standards for making selections of those whom they allow to continue with their graduate training.

As an additional measure, the premilitary training period of graduate students may well be shortened. All of the specialty boards have agreed to allow credit for one year of military service to apply toward the minimum of the three years of training now required. Thus, it would seem that we should not insist that graduate students be deferred for more than two years. Furthermore, the course of instruction should be planned so as to provide the sort of training that will be most useful in military service. For example, the American Board of Radiology requires a minimum of six months full-time service in pathology and nine months in therapeutic radiology. Undoubtedly, the greater part of work done in departments of radiology of the Army and Navy consists of roentgen diagnosis, and for that reason training given preliminary to the call to military service could well be planned to emphasize diagnostic roentgenology. All of the training in radium therapy, part of the training in roentgen diagnosis and therapy, and possibly some of the training in pathology could be postponed until after the war. On the completion of such a modified two-year course the young man should be able to assume the routine duties of a radiologist in a military hospital. If, during the war, he can secure the training or experience which was omitted in his civilian residency, he could take the examination of the American Board of Radiology after serving one year. If such training were not available in the service, he could complete his residency after the war and then be eligible to take the examination of the Board.

During the past several years, medical schools, hospitals, and other medical institutions have adopted programs of graduate and postgraduate training. Each year, in an attempt to meet the standards required by this body, these institutions have improved the quality of this training until today it is the best to be had anywhere in this troubled world. It is obvious, therefore, that there are now enough civilian facilities to provide adequate graduate and postgraduate training to fill military needs, and I am sure that each and every institution will co-operate to the fullest extent in arranging its plan of training to meet the needs of military service. The American Board of Radiology is now canvassing its diplomates in order that it may know approximately how many are willing to volunteer. The Army and Navy have been asked to furnish an estimate of the number of radiologists needed. The Board should then be able to determine fairly accurately how many radiologists must be trained and the type of work they must be prepared to do. If necessary, institutions which have been approved for graduate training in radiology will be asked to arrange their courses so that the trainees will be competent to do military radiology at the end of two years and to increase the number of students accepted for training in order to keep up an adequate stream of radiologists for military needs. Furthermore, certain institutions will be asked to

provide refresher courses or intensive short courses for medical officers who may be sent by the Surgeon General of the Army or the Navy. All this can and will be done without expense to the government.

The number of radiologists that can be furnished will depend on the number of young men permitted to pursue training and on the length of the course prescribed. By omitting subjects not essential in military practice, thereby reducing the course to two years, well qualified radiologists can be trained. It may be possible to shorten the course still further, but this should be done cautiously, if at all, for competence is just as necessary as numbers. Similar principles can be applied to the other specialties in an effort to solve the problem.

I am presenting these facts and opinions not as the sole guide to a final solution, but as a stimulus to broad discussion that may result in a complete, fair, and efficient plan. That plan should take account not only of present urgent needs but also of future requirements; it should fulfill all the obligations of all concerned to one another and should keep the light of medical knowledge burning through the dark years that lie ahead.

Mayo Clinic, Rochester, Minn.

The Use of a Modified Opaque Meal in Gastroroentgenography[1]

Its Special Application in the Differentiation between Benign and Malignant Ulcers on the Lesser Curvature

RICHARD A. RENDICH, M.D., and M. H. POPPEL, M.D.

New York, N. Y.

THE PURPOSE of this paper is to describe the use of a modified opaque meal which permits the simultaneous demonstration of the internal gastric topography together with most of the gastric contour. Following ingestion of this meal it is possible, by suitable roentgen technic, to demonstrate on a single film the rugal pattern, as seen by the ordinary relief method, and the contour of most of the stomach as seen after complete filling with the ordinary barium meal. In this manner, contrast is maintained and at the

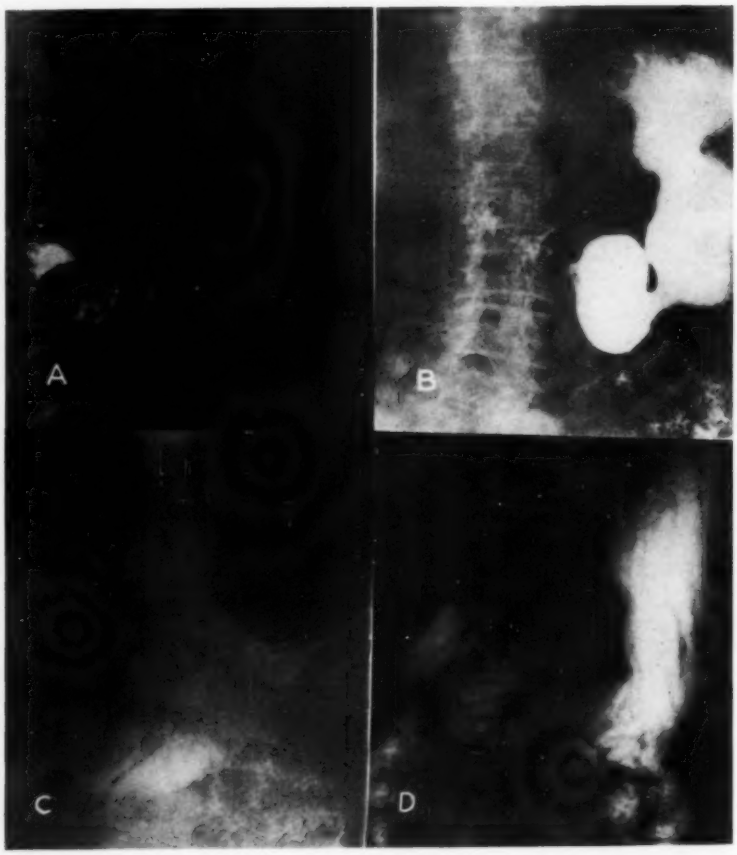


Fig. 1. Appearance of stomach after (A) simple rugal study; (B) simple barium meal; (C) double contrast (barium and gas); (D) modified opaque meal.

[1] From the Division of Roentgenology of the Department of Hospitals of the City of New York, Kings County Hospital. Accepted for publication in March 1940.

same time the finer variations of density, which may otherwise be lost, are depicted.

Inasmuch as gastric disease is in most instances first evident on the mucosal surface, the importance of demonstration of the internal topography of the stomach for early diagnosis is obvious. The latest advances in gastroroentgenography are particularly concerned with attempts to improve the known methods for demonstration of early mucosal changes.

studies, and later the compression method was popularized by Berg. Rendich in 1923 published a paper on "Roentgenographic Study of the Mucosa in Normal and Pathological States," describing the demonstration of gastric pathology by coating the mucosal surface with an adhesive opaque substance (3). In 1937, Poppel reported a study of the double contrast method in roentgenography of the gastrointestinal tract, as originated by Vallebona

Fig. 2. Normal stomachs as seen with the modified opaque meal.

Among the early pioneers in gastroroentgenography, the names of Holzknecht, Williams, Cannon, Haudek, and Carman stand out. Cole (1909) was one of the first to use the principle of sedimentation of bismuth subnitrate from a watery suspension. In 1919 a great step forward was made by the publication of Forssell's physiological and anatomical studies. In 1921, Akerlund introduced the thin layer method (compression) in duodenal bulb

of Genoa, and concluded that this "combined method permits detailed and fine examination of the gastric walls in a state of distention, different from the method of slight filling and the method of measured compression. The method adds to the contour that is obtained by ordinary methods, an image of depth in a hollow organ" (2).

At present, virtually all gastroroentgenographic diagnoses are based on the direct exhibition of anatomical changes,

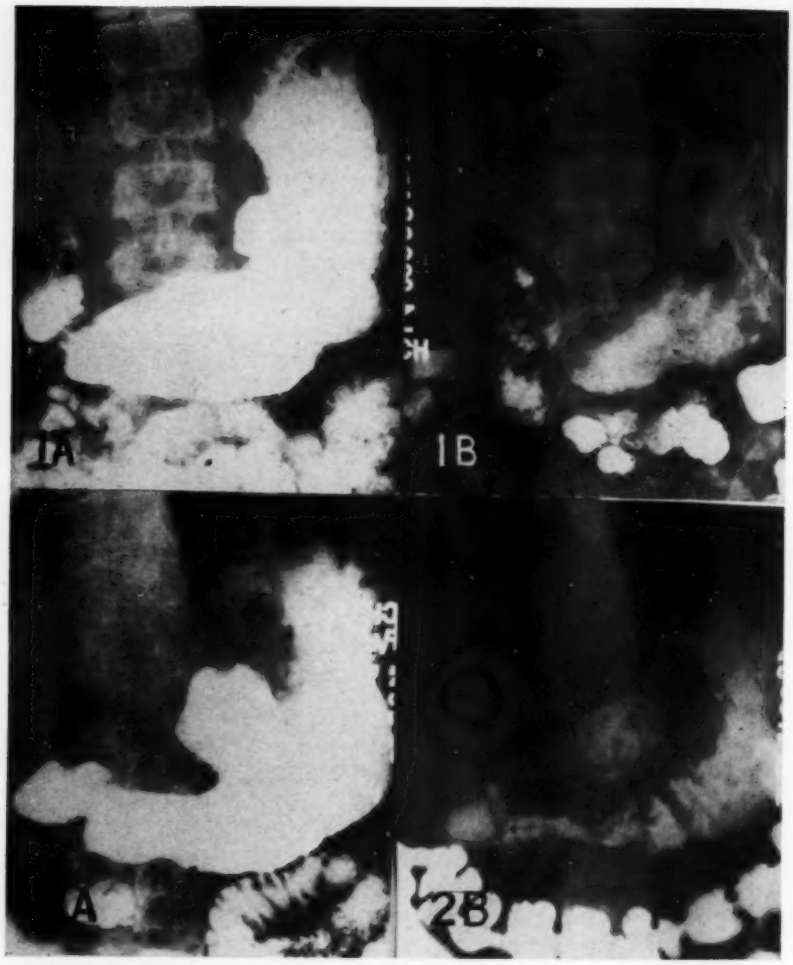


Fig. 3. Two cases of large lesser curvature ulcer proved benign. 1A and 2A show the appearance with ordinary filling; 1B and 2B with modified method.

and less and less significance is attached to functional behavior, which is considered to be chiefly of suggestive value. The single contrast meal, completely filling the stomach, affords a demonstration of its size, shape, position, functional behavior, distensibility, and relationship to the other abdominal organs. The relief method demonstrates changes on the inner surface of the collapsed or nearly empty stomach by the use of a thin coating, with the aid of compression or palpation. The principle of the sedimentation method is also the demonstration of the inner surface of the stomach by the deposit of barium from a water suspension or colloidally suspended barium sulphate. The double contrast method permits detailed and fine examination of the gastric walls in a state of distention and adds an image of depth in a hollow organ.

The disadvantages of the various methods now employed are to be taken into consideration. As to the single contrast method, the stomach is sufficiently opaque to obscure visualization by this means in

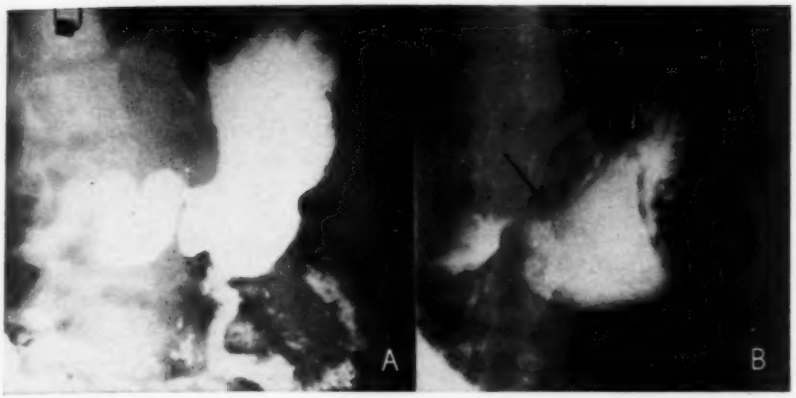


Fig. 4. Persistent constriction of the distal third of the stomach. A. Appearance with ordinary filling. B. The modified opaque meal demonstrated convergent rugae at this point, indicating a healed ulcer.

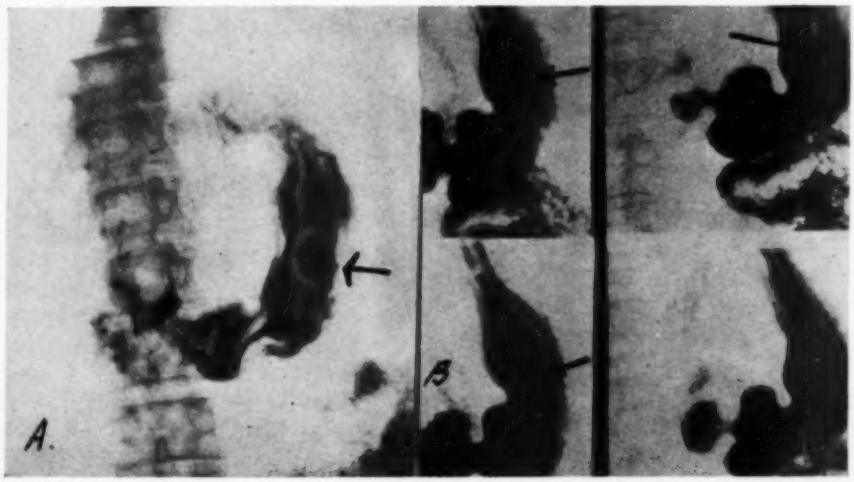


Fig. 5. Examinations with the modified opaque meal method. A. Large ulcer, mid third of stomach. B. Same case two months later, showing convergent rugae at the ulcer site.

any but the profile position. Also, since the rugae are not demonstrable, the smaller and earlier anatomic variations are missed. With the relief or thin layer method it frequently proves impossible to obtain the necessary compression of the upper part of the stomach because of interference by the ribs and cartilages. The double contrast method often produces distention with consequent ironing out of the rugal folds and diminution of the mucosal relief. The advantages of the method are sometimes lost as a result of eructations. Also it may prove dangerous in the presence of severe or deep acute ulceration.

The use of the modified opaque meal, as pointed out above, makes possible the simultaneous visualization on one film of most of the contour of the filled stomach and the gastric rugae. Thus it combines the two essential parts of what is considered a complete gastric examination. In addition, it permits a study of the mucosa in a state of partial distention.

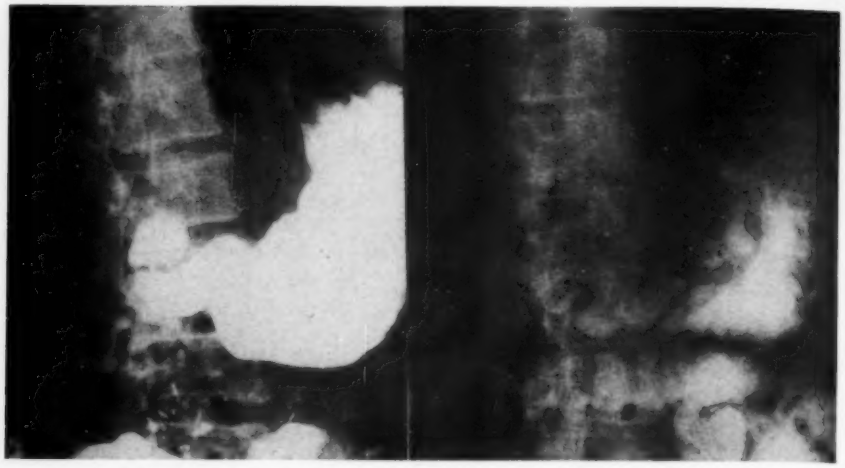


Fig. 6. Slight irregularity of the lesser curvature of the pars media suggestive of carcinoma. The view to the right shows the case as demonstrated by the modified meal. There is a large ulcerating new growth with a definite meniscus. This was confirmed at autopsy.

TECHNIC

For the opaque meal 20 grams of a mixture consisting of four parts barium sulphate, one part gum acacia, one part cocoa, and one part granulated sugar by volume, are added to 7 ounces of water and mixed thoroughly by mechanical means.

The patient is prepared as for the regular gastric examination. After ingestion of the mixture, films are made with such factors as are indicated to produce the proper degree of penetration. No compression is used except that which is afforded by the body itself.

While we have used the method for the differentiation of various organic gastric and colonic conditions, we have found it to be especially useful in distinguishing between large benign and malignant ulcers of the lesser curvature, using the following criteria:

1. In the presence of benign ulceration the neck of the ulcer is present; in malignant ulcers it is lost, producing the meniscus sign.

2. When the ulcer is benign, the rugae are preserved and may show convergence; with a malignant ulcer the rugal pattern is lost and the mucosa appears granular.

3. With the benign ulcer there is a uniform density in the niche; with the malignant ulcer the density may be irregular.

CONCLUSIONS

1. A single film method for the demonstration of the gastric rugae while most of the stomach is full, after the ingestion of a modified opaque meal, has been presented.

2. While we have used the method generally for the recognition of organic gastric and colonic disease, we have found it particularly valuable in the differentiation between benign and malignant ulcers of the lesser curvature.

114 East 54th St., New York, N. Y.

REFERENCES

1. CARTY, J. R., AND MERRILL, V.: Some Essential Considerations of the Technique of Gastro-intestinal Radiographs. Radiology **26:** 531–534, May 1936.

2. POPPEL, M. H.: Double Contrast Method in Roentgenography of the Gastro-Intestinal Tract. Am. J. Roentgenol. **37:** 379–381, March 1937.

3. RENDICH, R. A.: Roentgenographic Study of the Mucosa in Normal and Pathological States. Am. J. Roentgenol. **10:** 526–537, July 1923.

Radiation Effects on the Blood Vessels[1]

Part II: Inflammation; Degeneration; Suppression of Growth Capacity; Retrogression; Necrosis

J. BORAK, M.D.

Lecturer on Radiology, New York University, School of Medicine

INFLAMMATION

WITH INCREASING doses of radiation hyperemia and edema are succeeded by inflammation.

The first cells encountered in the perivascular tissues after irradiation are small round cells which by all available methods have been identified as *lymphocytes*. They may be found wherever edema develops, even in the absence of erythema. They are present as early as the first erythema, and are seen also in all late conditions following irradiation. In other words, there is hardly any effect on the blood vessels in which lymphocytes are not found in the perivascular spaces.

The *erythrocytes* are the next blood cells to leave the capillaries. An accumulation of erythrocytes may first be detected microscopically in the stage of the second erythema and more distinctly in the third erythema. They are found also in the stage of late chronic changes, especially in the skin of persons exposed in the professional use of rays (Lazarew). Either an accumulation of red cells or of the blood pigment (hemosiderin) may be present.

The *leukocytes* are the last blood cells to appear on the scene. Their delayed appearance has been stressed by Scholtz, Fahr, Dahl, Colwell and Gladstone, and by Rottmann for grenz rays. One is especially impressed by the absence of leukocytes in the case of an intense erythema. "They do not appear in the quantity in which they are usually seen in a skin inflammation of like intensity" (Miescher).

The appearance of leukocytes heralds the phase of suppuration or inflammation in the narrower sense of the term. Once released from the vessels, they tend to outnumber the other elements, while, owing to their mobility, they can move to areas distant from the vessels from which they migrated. They are usually associated with a fibrinous exudate and are deposited on the surface of the skin and mucous membranes, where the epithelium has been destroyed by the rays. Together with the remnants of the necrotic epithelial cells, and fibrin, they form a yellowish pseudomembrane, covering the denuded corium. This gives rise to the well known clinical picture designated as exudative or moist epidermitis (epithelitis) or, more correctly, epidermiolysis (epitheliolysis) (Fig. 4). In contrast to the lymphocytes and erythrocytes, the accumulation of which can be recognized only microscopically, the presence of polymorphonuclear leukocytes may be deduced clinically from the observation of a pseudomembrane. This serves at present as a basis for the biological dosage according to Regaud and Coutard, just as the erythema was previously used by Seitz and Wintz.

From this description it appears that the cytological sequence of the inflammatory products, as first established by Borrel (1893), is reversed in the case of inflammation caused by radiation. In an inflammatory process of bacterial origin "the first cells to migrate into an inflamed area are the polymorphonuclear leucocytes" (Menkin); the lymphocytes appear much later "to act as scavengers when the inflammation irritant has been overcome" (Menkin). That the opposite order is seen in post-radiation inflammation is due to the fact that the inflammation in this case is an aseptic one and therefore free of substances able to attract the leukocytes. Absence of leukocytosis is to be accounted for on this same basis.

The order of appearance of the blood cells in the perivascular tissues suggests

[1] Continued from April, page 492.

that the cells emigrate from irradiated blood vessels in proportion to their size, the lymphocytes being the smallest, the erythrocytes the intermediate, and the leukocytes the largest blood elements. It appears likely that this sequence is characteristic of any kind of inflammation in which the emigration is not influenced by chemotaxis, but is caused merely by a damage to the vessel walls. The greater the damage, the greater the dilatation of the vessels with subsequent slowing of the blood stream and the greater the permeability of the endothelial cells, so that elements of increasing size are permitted to pass the walls.

In the *arteries and veins*, the inflammatory process induced by irradiation takes quite a different course. As has been mentioned, with a given dose the swelling of endothelial cells is less pronounced in the larger vessels than in the capillaries. Hence in the former the increase in permeability of the endothelium does not attain the same degree as in the latter. Furthermore, the muscle and connective tissue comprising the walls of the arteries and veins offer an even stronger resistance to the emigration of blood cells than to the exudation of serum. Consequently, the corpuscular elements are unable to emerge from the confines of the vessel walls. It is to this course of events that the chief distinguishing characteristics of the inflammatory reaction of the capillaries on the one hand, and the arteries and veins on the other, are attributable. In the case of the capillaries, inflammation develops *in the adjacent tissues*, while with the veins and arteries the inflammation occurs *in the vessel walls*. All kinds of blood cells penetrate the walls of the vessels, particularly polymorphonuclear leukocytes, which gradually increase until they outnumber all other types. These cells infiltrate all the layers constituting the walls, producing a pathological picture which is indistinguishable from a true arteritis or phlebitis. This process continues until the blood, which supplies the cellular elements of inflammation, ceases to flow.

Added to endothelial swelling and subendothelial exudation, this infiltration of the walls contributes further to the narrowing of the lumina of affected vessels and to complete occlusion with cessation of blood flow. The significance of this phenomenon will be described in greater detail below.

DEGENERATION

As the amount of absorbed radiant energy increases, the degree of disintegration of cell proteins reaches the point of coagulation. According to the concept of Heilbrunn and Mazia, this takes place when calcium is released from organic combinations in the cell membranes, in a manner essentially identical with coagulation of blood. The process of coagulation is associated with an increase of viscosity which at first, as has been mentioned, is considerably diminished. The process starts intermittently in different areas, which assume the appearance of granules surrounded by protoplasm in a state of liquefaction. When this stage is reached, the liquefied substance about the granules appears *vacuolated*. Gradually the droplets increase in size and fuse, while the process of coagulation continues simultaneously. The granules, when first formed, stain like normal protoplasm, from which they cannot be distinguished. The vacuoles, on the other hand, do not stain at all and are clearly visible from the very beginning. Hence the extent of *vacuolization* serves as an indication of the degree of coagulation of the protoplasm.

The same description applies to the nucleus of the cell. Here, too, a process of vacuolization occurs. Eventually both protoplasm and nucleus are riddled with vacuoles.

In the nucleus, the process of swelling leads to still another phenomenon. Since radiation favors gel formation in colloidal solutions and "at the time of division the chromosomes appear in the form of stiff gels" (Heilbrunn), there is induced, eventually, a division of the nucleus. One of the most peculiar radiation effects thus

makes its appearance. A process of mitosis is initiated in the damaged cells. The endothelial cells, physiologically in a state of rest, begin to multiply, increasing in number until the endothelium is composed of several layers. Newly formed layers are found especially on the external surface of the endothelium, obviously because the cells produced on the internal surface are swept away by the blood stream. In the end, the endothelium appears thickened, the lumen of the vessel is narrowed, and its function of metabolic exchange is impaired.

This process of multiplication of the endothelial cells apparently takes place merely when the process of vacuolization has not advanced too far. In the latter event, amitotic cell division may be seen and irregularities in size and shape of the nucleus and other abnormal nuclear patterns are abundant.

One might see in these phenomena an expression of the "power of stimulation" attributed to rays when used in small doses. Such an opinion would be quite wrong, in the first place because the proliferation of the endothelial cells is seen not after small but only after very heavy doses, and in the second place because similar phenomena are the regular sequelae of severe damage from any other source. In glomerulo-nephritis, for example, Boyd stresses "the swelling and proliferation of the vascular endothelium. These cells show numerous mitoses and may be two or three layers in depth, so that the loop is seriously obstructed." Proliferation of the endothelial cells occurs, also, in the sheath of Schwann, when the nerve fiber is mechanically separated from its cell of origin. Thus the proliferation seen in irradiated endothelium is to be considered a pathological process, initiated by abnormal conditions, accompanied by retrograde changes, and heralding complete dissolution.

As to the *arteries and veins*, these are composed, apart from the endothelium, of both connective tissue (fibrous and elastic) and muscle tissue, in varying

Fig. 4. Epidermiolysis (wet epidermitis) following a dose of 5,000 r given in twenty sessions, 250 r at each session.

proportion, depending on the function of the vessel. Veins bear the greatest proportion of fibrous tissue, while elastic tissue predominates in the larger arteries, and muscle tissues in smaller ones. The degeneration induced by radiation in these tissues manifests itself partly by changes common to all of them, partly by changes varying in accordance with their special structures.

The common effects are derived from the disintegration of the cell proteins and lead to changes which have already been described in the endothelial cells. The osmotic pressure increases, with attraction of fluid from the blood serum. As the fluid enters into and spreads between the cells, these lose their distinct outlines and are separated from one another. The process is more pronounced in the looser connective tissue than in the muscle tissue, and more pronounced in the latter than in the elastic membranes. The greatest edema is found in the intima between the endothelium and the adjacent fibrous tissue. The swelling of the cells leads to alterations also similar to those already described in endothelial cells: first an in-

crease in size, then the appearance of vacuoles, finally a mitotic or amitotic proliferation leading in part to an increase in the number of nuclei and in part to a formation of new cells and fibrils. In this way a hypertrophy of the fibrous, elastic, and muscular tissue may result.

Of these changes, hypertrophy of the fibrous tissue, called intimal *fibrosis*, is of the most frequent occurrence and, practically, of the greatest importance. Its significance lies in the fact that it may bring about a narrowing of the lumen. When the *arteries* are affected, a more or less pronounced ischemia is produced in the tissues which they supply. As a result, the following symptoms are observed: depigmentation of the skin; hornification of the epidermis; degeneration of the capillaries, with less intense formation of erythema and granulation tissue; hyalinization of the connective tissue; atrophy of the parenchymal cells; reduced sensitivity to the rays; increased susceptibility to mechanical insult, chemical irritants, and excitants of infection (Fig. 5).

Intimal fibrosis in the *veins* gives rise to telangiectasia, which will be discussed in greater detail later.

Further phenomena of degeneration observed in the walls of irradiated vessels are hyalin degeneration of the fibrous tissue, hyalin and fatty degeneration in the muscle tissue, and granular degeneration of the elastic tissue, with the loss of its specific affinity to certain dyes.

SUPPRESSION OF GROWTH CAPACITY

Besides the ability to regulate the metabolic exchange between the blood and tissues, endothelial cells are also endowed with the capacity to form new blood vessels. This property, however, is limited to the capillaries. "Blood vessels which have muscle and elastic fibres in their walls, of both late embryonic stages and adult, are devoid of this capacity" (Maximow). Even in the capillaries this ability is normally dormant, that is, merely potentially existent, coming into effect only under certain conditions, the most important of which in the adult organism are inflammation and injury. Under the stimulus of these phenomena, a granulation tissue is formed consisting of connective tissue and capillaries. The parent cells responsible for the rebuilding of the damaged tissues are the fibroblasts and the endothelial cells, the latter functioning as angioblasts at this stage and properly so called.

The formation of new capillaries takes place by means of a process of budding or sprouting, similar to that by which the primitive blood vessels of the embryo are built up. Thus, in the stage of inflammation, as Stricker pointed out, the capillaries regain embryonic qualities.

According to Arnold, the process of sprouting may be described as follows: The newly formed offshoot appears first as a thickening of the capillary wall. Gradually, it takes on a triangular shape, and subsequently is transformed into a thread which, growing in length, unites with a similar thread arising from another capillary. The thread represents a syncytium without definite cell boundaries. The new offshoot, primarily solid, subsequently becomes hollowed out by the flaking off of small particles of the protoplasm in its center. In this way a canal results, in which the detached particles of protoplasm mix with the red and white blood cells streaming in the newly formed vessels. Coincidentally, nuclei originating by division of the endothelial cells of the old capillaries penetrate the newly formed capillaries, which gradually become wider and longer. Thus the following phases may be distinguished in the formation of new capillaries: multiplication of the nuclei; expansion of the protoplasm; fragmentation of the protoplasm; return to the state of normal endothelial cells. In other words, there is a phase in which the endothelial cells are transformed into angioblasts, which, after partial desquamation, revert to endothelial cells.

Endothelial cells showing vacuolization and pathologic mitotic or amitotic proliferation following irradiation prove un-

able to form new capillaries when there is a need for them. In other words, these cells may be so damaged by the rays that, though they may reproduce themselves, they prove incapable of transformation into angioblasts. The loss of the ability to form new capillaries may be considered as one of the most important radiation effects. The natural consequence is that capillaries destroyed by radiation or other pathological process find no replacement. Furthermore, no granulation tissue can be formed when an area damaged by an inflammation or injury must be repaired. These consequences of the loss of the power to form new vessels aggravate any biological effect caused by radiation, as far as the normal tissues are concerned. The result is that radiation necrosis assumes an indolent character. The process of repair is suspended until the damaged capillaries recover and regain their angioblastic proclivities. Not only do the damaged capillaries fail to produce new blood vessels when and where the need arises, but they are themselves prone to undergo complete dissolution under the added insult of inflammation or other injury in the neighborhood. Summarizing, one may say that the loss of the power to form new vessels means, essentially, that the damaged capillaries cannot meet the demands made upon them and they become an easy prey to necrotic dissolution under harmful environmental conditions.

RETROGRESSION OF BLOOD VESSELS

By retrogression of blood vessels is meant a disappearance of the capillaries electively; that is, without a similar effect on the arteries or veins. Such a radiation effect can be obtained only in *growing* capillaries, that is, in those engaged in angioblastic activity. Growing capillaries are encountered (*a*) in the embryo, (*b*) in granulation tissue, and (*c*) in certain hemangiomas. They have in common the ability to regress spontaneously, without any interference from external agents, merely as a consequence of certain physiological conditions.

Fig. 5. Fibroatrophy following irradiation. Dose unknown.

According to Clark, who followed this phenomenon in living vessels in the rabbit's ear (1932), the process of spontaneous retrogression takes place in the following way:

"The first change to be noted is a narrowing of the lumen. Next there appears an interruption of the lumen by the formation of a solid portion. The solid part gradually increases in extent and becomes narrower until a varying part of the former capillary is represented by only a fine thread. This thread becomes thinner until it is barely visible and eventually disappears. There is nothing left to mark the site of the former capillary.

"The conclusion seems justified that a vessel which is connected with the rest of the circulatory system of vessels retrogresses and disappears, if the circulation within it ceases for a sufficient length of time."

This description may also serve to illustrate the retrogression of growing capillaries initiated by radiation. It is known that, as long as the capillaries are not yet fully developed but in the stage of growth, they form a syncytium of very thin vessels.

In such young capillaries the swelling following irradiation is quickly succeeded by complete occlusion of the capillary lumen. With this sealing, no blood can enter the capillary. Circulation ceases; the endothelial cells protruding into the lumen die, a solid portion remaining. This gradually dies out and is absorbed, so that, as Clark states, "eventually there is nothing left to mark the site of the former capillary."

NECROSIS

Radionecrosis of the blood vessels must be viewed from the standpoint of the individual tissues composing their walls. Apart from the endothelium, which has already been discussed, two tissues can be distinguished: connective tissue and muscle tissue.

The connective tissue consists of fibroblasts, fibrocytes, and the fibrils.

Fibroblasts are encountered in the embryonic stage of development, in granulation tissue, and in early keloids. They possess the faculty of multiplication by mitotic cell division. Of particular interest is the structure of the protoplasm. Here, according to the modern conception (Jordan), at a certain stage a differentiation may be drawn between an endoplasm and an ectoplasm. Fine fibrils appear in the ectoplasm. Presently these fibrils are separated from the cells and fill the intercellular spaces, supporting the other tissues. Thus, multiplication takes place, on the one hand, while on the other a transformation of living cells into lifeless fibrils is effected. This process resembles, to a certain extent, that in the basal cells of the epidermis, hair follicles, and other tissues composed of a germ layer undergoing continuous transformation with a lifeless tissue as the final product.

Fibrocytes are the cells encountered in the connective tissue of adults under the normal conditions of life. They represent the fibroblastic cells remaining after separation of the fibrils. They are small, spindle-shaped, composed of endoplasm only, but are capable of assuming fibroblastic activity when it is required.

The fibers represent the final result of the process of transformation occurring in the protoplasm of the fibroblasts. Since "fibroblasts have inherited the property of producing elastin in addition to collagen fibrils" (Mallory), two types of fibers can be differentiated: *collagenous* fibers, either loose or dense, and *elastic* fibers, either in the form of strands or membranes. Beside the differences in the chemical constitution of the proteins characteristic of the collagen and the elastin, respectively, "the elastic fibers develop later than the white fibers and are not formed in the youngest connective tissue" (Bremer). In contrast to the collagenous fibers, the elastic fibers do not consist of single fibrils but form homogeneous threads without any morphological differentiation. Finally, collagenous fibers have no specific staining reactions, while elastic fibers can be stained by certain dyes (Weigert's, for example).

The second main tissue constituting the walls of the blood vessels is represented by the *smooth muscles*. "In the blood vessels, which at first consist only of endothelium, the muscle cells are formed . . . by a direct transformation of mesenchymal cells" (Maximow). This applies to the embryonic stage as well as to the adult stage in the course of the formation of new blood vessels. "Completely developed smooth muscle cells in the adult organism keep the ability to divide by mitosis to a certain degree. . . . But this capacity for regeneration is small and, as a rule, great defects in the smooth muscle tissue heal by scar formation" (Maximow). Thus, in contrast to the fibroblasts, the smooth muscle cells have only a very limited capacity for regeneration and no ability for transformation into other cell forms.

On the basis of these physio-anatomical facts the radiobiological behavior of the tissues in question can easily be understood.

The fibroblasts resemble the angioblasts as to origin, structure, and activity. Like the latter, they possess the capacity of multiplication and transformation into

lifeless final products, namely fibrils. Tissues of this multiform character are, as is known, electively radiosensitive. They can be made to disappear by direct action of the rays, which damage their capacity for regeneration and transformation so that, as a result, the cells disappear.

The fibrocytes and the muscle cells, on the other hand, devoid of this capacity for regeneration, cannot be caused to disappear by *direct* action of rays, but merely to degenerate. Vacuolization, hyalinization, fatty degeneration, and pathologic proliferation result. A complete disappearance of these tissues can be obtained only *indirectly* by means of nutritional damage, most frequently in the course of an inflammation associated with leukocytic infiltration and pus formation.

The *collagenous*, and more particularly the *elastic fibers*, representing almost lifeless tissues, are practically radioresistant. The strongest doses can produce hardly more than swelling of the fibrils and their consequent separation. Nor does destruction result indirectly, since, owing to their homogeneous structure, these elements offer strong resistance to spreading of the leukocytes and the accumulation of pus. Hence they persist the longest, a fact emphasized by Gassmann as far back as 1898, and confirmed experimentally by Lacassagne. In animals in which large blood vessels, such as the carotid, were submitted to intense irradiation by radium, the endothelium, intima, muscle tissue, and the adventitia became necrotic, but the fibroelastic coat persisted, so that the circulation of the blood could be maintained. Similar observations were made by Dobrovalskaïa-Zavadskaïa in animal experiments and by Letullo in the blood vessels of the irradiated human uterus.

Since, in adults, neither angioblasts nor fibroblasts nor myoblasts are normally present in the walls of an artery or vein, no complete *destruction* can be achieved by *direct* action of the rays on the tissues comprising these vessels. Only degenerative changes in the endothelium, fibrocytes, and muscle cells, as described above, can be produced *primarily* by radiation in vessels covered with a fibromuscular coat. Most of the *necrotic* changes encountered in the walls of the irradiated blood vessels occur in the course of an *inflammatory process*, which partly destroys the walls and partly occludes the lumen. In other words, the fibromuscular walls of the irradiated arteries and veins are destroyed as a result of an arteritis and phlebitis induced by rays. This process may be associated with thrombosis.

Of prime importance is the fact, previously discussed, that a dose producing an exudation and emigration of leukocytes through the endothelium of the capillaries, with a resulting inflammatory process in the surrounding tissues, does not suffice to produce an inflammation in the walls of the arteries or veins. Only after a considerable increase of the dose do exudation and emigration of leukocytes through the endothelium of the arteries and veins take place, so that an arteritis and phlebitis result. In that case the walls of the blood vessels serve not only as a path of invasion of the perivascular tissues, but they are themselves the object of invasion. In practice, then, irradiation should be limited to the production of an inflammation in the perivascular tissues. Irradiation leading to an emigration of leukocytes through the endothelium of the capillaries may be considered permissible, but doses causing emigration of leukocytes through the endothelium of the arteries and veins should be avoided. The reason lies in the specific function of the blood vessels. When these are damaged, not only do they themselves suffer but all the tissues supplied by them are affected. As long as merely the capillaries are damaged, the subsequent tissue destruction is limited to very small areas and may still be compatible with the preservation of essential physiological functions, the more so since anastomoses usually exist between these small vessels. But when the larger vessels, in particular the arteries, are damaged, extensive areas of tissue may be subsequently destroyed, regardless of their

natural radiosensitivity and their physio-anatomical properties. As a result, tissues of vital importance may undergo necrosis and the death of the whole organism may result. Such tissue necrosis may follow even though the inflammatory process proves of merely transitory character so that the vessels themselves do not become necrotic but recover after a lapse of time.

A similar result may follow a fibrosis induced by rays in the walls of the arteries. This phenomenon usually develops as a result of repeated treatments with high single doses distributed over a prolonged period of time. Arteriofibrosis does not cause necrosis primarily, but merely an atrophy of the parenchymatous tissues. While the cells atrophy, the fibrous tissue usually proliferates so that the fibrosis of the arteries is followed by fibrosis of the tissues. In the skin this is associated with depigmentation leading to the characteristic post-radiation leukoderma. Injuries produced in a skin so altered may have extremely serious sequelae. Wounds and infections do not heal because the capillaries have lost their power of regeneration. The granulation tissue is, therefore, defective. In addition, the arteries, already compressed by the process of fibrosis, may be completely occluded under circumstances which normally would leave them unmolested.

The course of radionecrosis may be observed in the skin from its very beginning. Suppose that in one session a dose be given sufficient to produce a radionecrosis (about 2,500 r of filtered rays if a large field is used). After a few hours the first erythema appears, followed after a few days by the second erythema, which imperceptibly merges into the third erythema. Epidermiolysis next makes its appearance. The defect is replaced by a new epidermis, growing as usual from the non-irradiated neighborhood, but instead of being hyperpigmented the new epidermis is almost depigmented. About three months after irradiation a small painful ulceration appears in the center of the field, subsequently spreading in all directions (Fig. 6).

Two points draw the special attention of the observer. (1) The necrosis is sharply confined to the area of the earlier erythema. (2) The necrosis begins with the loss of the epidermis. The first indicates, as has been mentioned in discussing the erythema, that the point of attack of the rays is to be sought in the superficial vessels, above the level of the arched arterioles. The difference between the erythema and the necrosis consists mainly in the fact that in the erythema phase the superficial vessels are dilated, while in necrosis they are obliterated or even destroyed.

The fact that necrosis begins with the loss of the epidermis suggests that the subpapillary plexus has been destroyed. Microscopic examination shows in fact that all superficial vessels, including the papillary capillaries and the subpapillary arterial and venous plexuses, are completely destroyed in radionecrosis of the skin.

There is but one kind of blood vessel whose primary destruction by radiation will explain both the limitation of necrosis to the radiation field due to the integrity of the arched arterioles, and the initial loss of the epidermis due to the destruction of the subpapillary plexus. These vessels are the *arteriovenous anastomoses* (see Fig. 2). Hoyer in 1873 was first to point out the existence of these connections between the arteries and veins, in the skin, and their existence was confirmed by Grosse, Spalteholz, and others. Recently, Clark and Zweifach have stressed the importance of these vessels. Zweifach describes them as having a caliber of 12–15 μ in contrast to the 8 μ caliber of the true capillaries. Accordingly, they contain 5–7 cells in cross-section instead of 2–5, and, because of their greater width, may harbor more blood.

A further difference from the capillaries lies in the fact that, apart from the endothelium, the arteriovenous anastomoses possess a coat consisting of fibrous as well as elastic fibers and above all a well developed layer of muscle cells. Due to this structure the walls of these vessels are, ac-

cording to Spalteholz, at least twice as thick as those of the arteries and veins which they unite.

The well developed muscular coat makes it evident that the arteriovenous anastomoses are of no avail in metabolic exchange. It indicates, however, a strong tonus and suggests that normally these vessels might be closed, in which event the blood circulates through the superficial capillaries in the papillary portion of the corium.

The situation changes, however, when the papillary capillaries have been damaged by rays. The arteriovenous anastomoses then become the only path for the circulating blood in the corium. Consequently the vessels dilate and are packed with blood cells; the blood flows slowly and stagnates. The walls of the blood vessels are also damaged by the rays; there are swelling and vacuolization of the endothelial cells, and an edema and slight infiltration of the wall. As a result of the two events, the slowing of the circulation and the damage to the vessel walls, a thrombus is formed and the lumen is occluded. In other words, a thromboarteritis is produced in the arteriovenous anastomoses. As a consequence, the circulation ceases in the plexus subpapillaris. Subsequently, all vessels supplied by the plexus and all tissues supplied by those vessels break down. The entire cutis, first the epidermis and then the corium, becomes necrotic, and radionecrosis makes its appearance. Histologic examination confirms the clinical observation: all the superficial blood vessels, the arteries and the veins, and all tissues situated in the corium, the epithelial cells and connective tissue, are converted into a uniform necrotic mass. This area is usually surrounded by a zone in which the tissue elements are dead but still morphologically distinguishable from each other. Then follows a wall of leukocytes, then one of lymphocytes; finally an attempt to form a granulation tissue may be deduced from the presence of newly formed blood vessels and young fibroblasts.

Fig. 6. Radionecrosis. Dose unknown

When a larger field is irradiated, the necrosis usually starts in its center, obviously because side communications such as the arched arterioles and the arteriovenous anastomoses are able to maintain the circulation in the periphery of the field. But once necrosis starts, it spreads toward the borders of the radiation field, stopping sharply as soon as the vessels not damaged by the rays are reached.

In the direction of the depth, necrosis progresses until a zone of relatively undamaged vessels is reached. This depends on the quantity of rays absorbed in the depth and therefore also on their quality, since with hard rays a relatively larger amount of the dose applied will reach a given depth than in the case of soft rays. The caliber of the vessels also plays a part in determining the ray effect. The deeper the vessels, the wider their lumen, and therefore the longer the period required for the narrowing necessary to produce necrosis of the tissues. The duration of a radionecrosis corresponds, therefore, to the latent period of the ray effect in the relatively largest artery affected in the irradiated area. The site of this

vessel determines the depth of the radionecrotic area.

It should be borne in mind that in no artery of medium size, as, for example, the radialis, can an occlusion of the lumen be produced by radiation. The reasons for this are the caliber of the lumen and the structure of the wall. It is safe to say that even with quite excessive doses only the small arteries, that is vessels less than 3 mm. in diameter (Bailey, Benda, Maximow, etc.), can be narrowed by radiation to an extent causing ischemia of the tissues which they supply. As to the structure of the wall, the larger arteries contain more elastic tissue, especially between the intima and media. This elastic layer not only offers strong resistance to the rays but also to the spreading of the inflammatory cells tending to infiltrate the wall of the vessel.

In this respect a crucial difference exists between necrosis caused by rays and that developing in the course of thromboangiitis obliterans (Buerger's disease), which undoubtedly have certain features in common. The difference lies in the fact that while in radionecrosis it is the small blood vessels, in thromboangiitis obliterans it is the large ones that are affected. The practical consequence is that radionecrosis can frequently be cured by local excision followed by transplantation of normal skin, while in Buerger's disease, an amputation, far from the site of necrosis, must often be done.

It may be stressed that radionecrosis does not spread like an infection, involving more and more tissues previously normal, but that it expands only as far as the rays have produced a narrowing of the lumina of the blood vessels. It sometimes occurs, of course, that instead of necrosis being caused by inflammation of the vessels, the latter may be produced by the radionecrotic tissues. This is more often seen in the veins than in the arteries, not because the former are more radiosensitive than the latter, as Windholz believes, but because of the predominance, in the veins, of loose connective tissues over muscle and elastic tissue. But the periphlebitis or periarteritis caused in this way does not suffice for the spread of necrosis of the tissues unless an endophlebitis or endarteritis has been produced by rays in these vessels. With Benda we may say that periarteritis and periphlebitis are significant only in so far as they are associated with endarteritis and endophlebitis, respectively. This is evidenced by the fact that, although in the neighborhood of a radionecrotic zone inflammation is almost invariably present, no radionecrosis takes place outside the field of irradiation. In other words: in contrast to necrosis resulting from an infection, radionecrosis develops only as far as the vessels are damaged from within. Infectious arteritis and phlebitis start in the adventitia, while radiation arteritis or phlebitis starts in the endothelium.

Beside the radionecrosis starting in the arteriovenous anastomoses below the subpapillary plexus, there is still another form, which begins in the terminal arterioles above the subpapillary plexus. While the first type is clinically associated with an ulceration, the latter is accompanied by a reaction called moist radioepidermitis (Regaud, Coutard). This reaction is characterized by a destruction of the epidermis (epidermiolysis) coinciding with an inflammation of the underlying derma. This inflammation, since it follows fractional irradiation, with comparatively small single doses, has a milder course than the first type, which is caused by a high dose given in a single session. As a consequence only the superficially situated terminal arterioles become involved to a degree leading to occlusion. This effect results first because the terminal arterioles are comparatively narrow and secondly because they are endowed with comparatively few muscle cells. The occlusion of these terminal arterioles leads to the collapse and obliteration of the papillary capillaries in which they branch. Since the latter do not communicate with other vessels, the area which they supply with blood, that is the papillary portion of the corium, even-

tually undergoes necrosis. All these events can easily be recognized by capillary microscopic and histologic examinations. One finds in such cases that the newly formed epidermis, instead of its characteristic, wave-like boundary, presents an almost straight line toward the corium and that the most superficially situated blood vessels are those of the subpapillary plexus.

While following the epidermiolysis the epidermis is replaced from the unirradiated epithelium in the neighborhood, the destruction of the papillary portion of the corium and the papillary capillaries seems to be a permanent radiation effect. In two cases observed by Müller, no regeneration of these tissues was found after six and ten years. This suggests that the subpapillary plexus is unable to produce new capillaries, either because of radiation damage or a primary lack of the power to form true capillaries. The different fate of the papillary body and the epidermis indicates that the unity between them, as proclaimed by Kromayer, Pinkus, and others, does not exist from the radiobiological standpoint.

(*To be concluded*)

EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

The Roentgenologist's Report: Who Should Receive It?

Insurance coverage for hospital and medical care is ever increasing; hence the impression which radiologists individually and as groups make upon the insurance carriers bears importantly upon the future status of roentgenology as a speciality in the practice of medicine.

Time was when there were no workmen's compensation laws, and all workmen's accidents and illness were paid for out of the workman's pocket. These days were for the most part before the widespread application of x-rays to medicine. Now a large part of the diagnostic examinations done by roentgenologists in hospitals or private practice is paid for by some insurance company, or by the self-insured employer.

A question rather persistently presents itself as to what should be done with the roentgenologist's report in this ever-increasing volume of insurance work. Inquiry directed somewhat at random to leading roentgenologists in a number of our larger cities has indicated considerable variation of practice in this matter. All report primarily, of course, to the referring physician, sometimes with a single copy and at others with several copies so that the referring physician may himself mail a copy to the insurance company if he so desires. (Some insurance companies routinely require the attending physician to submit a copy of the roentgenologist's report with his own "first report" when a roentgenologist has participated in examination of the workman.) Some roentgenologists routinely submit copies of the report with the statement for services rendered, thereby indicating the basis for the charge, to the third party involved in this type of medical care. Others send this copy or copies to the insurance company only when requested or demanded as a requisite to obtaining payment for the service. It is significant that all radiologists agreed the insurance company has a legal right to the report, since it is paying for the medical service rendered, which is *ipso facto* the roentgenologist's opinion.

When one thinks this matter through carefully, it becomes apparent that it would be a highly desirable circumstance if the insurance company were to receive regularly a copy of the roentgenologic interpretation and opinion report. This would establish the fact that the charge for the service was based upon the nature and extent of the medical service rendered, and was not merely a charge for the taking and processing of films.

Proof is required, of course, in workmen's compensation work, and at times in health and accident insurance, that the injury or illness from which the workman is suffering was contracted or aggravated by or during his employment; hence the importance of adequate high-grade x-ray examination and of carefully considered competent roentgenologic opinion in affording the aid which roentgenology offers the patient, the referring physician, and the financially responsible agent, in helping to determine which conditions are compensable and which are non-occupational or non-traumatic.

It is a fallacy to contend that the insurance company representative, particularly the workmen's compensation company adjustor, is in no position to understand

the report, and that it may lead to misunderstanding. One might as well contend that reports of the attending physician or of the neurologist, orthopedist, or other specialist consultant, which are regularly submitted to the insurance companies, lead to misunderstanding. When such misunderstandings do develop, it is not the fault of the procedure, but rather the fault of the roentgenologist, who has erred in his interpretation, or more commonly merely failed to make himself familiar with the problems of the particular case.

If the roentgenologist will take care always to function in his capacity as a consultant and know the basic problems presented by each case in which he is submitting an opinion, this situation will not occur. Leaders in our field have often maintained that it is the roentgenologist's right to know the important clinical features of the case before submitting his final opinion on the x-ray findings. Never is this more important than in compensation insurance work, where so often some medicolegal consideration is required for the ultimate disposal of the claim.

The roentgenologist is not completely fulfilling his function as a consultant if he merely reads the films and makes no attempt to distinguish between the incidental and the significant abnormalities revealed in the roentgenologic study, or to differentiate disease processes which could well be related to an occupational hazard from those which are not so related.

For the roentgenologist to change his custom or habit of submitting only the bill to the insurance company, to including a copy of his findings with the statement, requires only the intelligent understanding of his purpose by his medical confreres. No criticism or complaint will come from the fair-minded attending physician or other consultant specialist called to assist in the diagnosis or handling of the case. They will realize that the roentgenologist is not attempting to usurp the responsibilities of the clinician, who must make the final correlation of the clinical, laboratory, and x-ray findings. They will understand that the roentgenologist is, within the limits of his examination, based on his background of special training and personally acquired experience, offering an opinion which should be of considerable value in arriving at the final diagnosis of the case, since it includes the use of "roentgenologic judgment," something which the clinician is seldom in a position to acquire adequately, and something which can properly be added to his own "clinical judgment" in arriving at his final conclusion.

Perhaps this is a matter which the American College of Radiology should properly consider at one of its future meetings. It need not be expected that an absolute rule shall be declared as the only ethical procedure in this matter, but it should be not too much to hope that the situation might be clarified by obtaining representative roentgenologists' opinions from al sections of the country, and thereafter enunciating a "desirable standard" to be added to future issues of the College Manual.

J. EDWIN HABBE, M.D.
Milwaukee, Wisconsin

I. SETH HIRSCH, M.D.

1880–1942

"He wishes to knit anew his connections with his oldest friends, to continue those recently formed, and to win other friends among the rising generation for the remaining course of his life. He wishes to spare the young those circuitous paths, on which he himself had lost his way." These words of Goethe served Smith Ely Jelliffe as an appropriate

I. SETH HIRSCH, M.D.
Portrait by Nikol Schattenstein

introduction to the Periclesian work of Dr. I. Seth Hirsch in the Appreciation prefacing the text "Contributions to Radiology."

I. Seth Hirsch was born in New York City on Dec. 3, 1880. He attended the College of the City of New York from 1895 to 1898, and received the degree of Doctor of Medicine from the College of Physicians and Surgeons, Columbia University, in 1902. In 1920 he was awarded a Diploma in Radiology by Cambridge University, England.

In 1910, after a Civil Service examination, Dr. Hirsch was appointed Director of Roentgenology at Bellevue Hospital, where for sixteen years endless opportunities for study and service made his life an arduous, happy, and busy one. When Bellevue was incorporated in the group known as Bellevue and Allied Hospitals, which included also Harlem, Fordham, and Gouverneur Hospitals, Dr. Hirsch became the General Director, a post which he held until 1926. From 1913 to 1917 he was also Director of Roentgen Laboratories of the New York Post Graduate Hospital, and for the three years before the entry of the United States into the first World War he was Professor of Roentgenography at the Medical College of that institution. Entering the Medical Corps of the United States Army as a captain in 1917, he was subsequently promoted to the rank of major.

Dr. Hirsch was director of the X-ray Department of Beth Israel Hospital in New York City from its inception until 1917, and again from 1929 until his death. There with the aid of Myron M. Schwarzschild, Physicist, he was able to delve into the many physical intricacies surrounding the growing field of radiology. At the time of his death he was serving as Consultant to the New York State Compensation Commission. Since 1933 he had been Professor of Radiology at the New York University College of Medicine. He was Vice-President of the Radiological Society of North America in 1927 and 1928 and was a Fellow of the American College of Physicians.

Throughout the years there have come from his work studies characterized by originality and a striving for simplification. Particularly noteworthy are his most recent contributions to the analysis of cardio-dynamic phenomena by permanent roentgen records. He also opened up a new field of kymophono-roentgenography, thus making possible the studying and recording of sound phenomena of the heart and the valvular actions responsible for them.

In 1920 his "Principles and Practice of Roentgen Technic" appeared, to be followed in 1925 by "Principles and Practice of Roentgen Therapy," a pioneer work in English deemed worthy of translation by Holzknecht and Spiegler. Two books that he had in preparation at the time of his death will be published posthumously. A volume entitled "Contributions to Radiology," consisting of forty-five scientific articles was published in his honor in 1939 by a group of former pupils, colleagues, and friends.

Broadly speaking, the fundamental significance of I. Seth Hirsch lay in the application of his scientific genius to a new and growing specialty. It is upon his contributions and work in the field of radiology, especially his ability to organize and teach, that his permanent fame securely rests.

Dr. Hirsch died on March 24, 1942, after a short illness. He leaves a widow, the former Miss Lila Calhoun Hindsman, of Fort Worth, Texas.

M. H. POPPEL, M.D.

RADIUM IN WARTIME

An interesting item appearing in the *London Hospital Illustrated*, 1940–1941, headed *£7,000 Hole in a Hill*, describes the measures which have been taken by that hospital for safeguarding its supply of radium. A disused lime kiln in an isolated spot many miles from the hospital serves both as a storage space and a laboratory where radon is collected and converted into therapy tubes and seeds for distribution to institutions throughout the country.

The London Letter appearing in a recent issue of the *Journal of the American Medical Association* is of interest in this connection, as it carries a note on air raid precautions for users of radium, issued by the British Minister of Home Security. Amounts of radium exceeding 1 mg. should be kept in a bore hole or a steel block. The former should be about 50 feet deep, lined with steel tubing, with a cement base and a concrete superstructure at the ground level, the latter having a door fitted with winch and cable to raise or lower the radium container. The steel block may be either round or square with a central cavity sealed by a screwed plug and a wall thickness of not less than 3 inches.

In hospitals in vulnerable areas it is suggested that radon be used instead of radium whenever possible. Radium therapy should not be given during an air raid except in a basement or ground floor room strengthened up to the approved air raid shelter standards. Transportation of radium should be by special messenger or passenger train, with proper protective measures.

Book Review

NASAL SINUSES, AN ANATOMIC AND CLINICAL CONSIDERATION. By O. E. VAN ALYEA, M.D., Assistant Professor, Department of Laryngology, Rhinology, and Otology, University of Illinois College of Medicine, Chicago. A volume of 262 pages with 82 illustrations and many tables. Published by Williams & Wilkins, Baltimore, 1942. Price $6.50.

This text is a consideration of the nose and paranasal sinuses based on anatomic studies carried out at the University of Illinois, the author's clinical experience, and a comprehensive review of the recent literature. Each sinus is considered individually, with emphasis on anatomic variations and their clinical significance. The text is illustrated by excellent drawings, photographs, and roentgenograms, and is summarized in tables. Diagnosis and therapy are also considered in relation to each sinus. There are, in addition, chapters on Histopathology, Acute Nasal Infection, Sinus Disease in Children, Relation of the Sinuses to Other Organs, Complications and Benign Growths, Allergy, and General Surgical and Non-Surgical Therapeutic Measures. Bibliographies and author and subject indexes are included.

This book provides an excellent review of current concepts of the physiology and therapy of the nose and paranasal sinuses. It is recommended for rhinologists and other practitioners interested in the anatomy, pathology, and therapy of the nose.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Annual Meeting, 1942, Atlantic City, N. J.

Section on Radiology, American Medical Association.—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio. Annual Meeting, 1942, Atlantic City, N. J.

ARKANSAS

Arkansas Radiological Society.—Secretary-Treasurer, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Joseph D. Coate, M.D., 434 Thirtieth St., Oakland.

Los Angeles County Medical Association, Radiological Section.—Secretary, Donald R. Laing, M.D., 65 N. Madison Ave., Pasadena. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary-Treasurer, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Society meets annually during annual meeting of the California Medical Association.

San Francisco Radiological Society.—Secretary, Earl R. Miller, M.D., University of California Hospital. Meets monthly on third Thursday at 7:45 P.M., for the first six months at Toland Hall (University of California Medical School); second six months at Lane Hall (Stanford University School of Medicine).

COLORADO

Denver Radiological Club.—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary-Treasurer, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday. Place of meeting selected by Secretary.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, Robert C. Pendergrass, M.D., Prather Clinic Bldg., Americus. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Chester J. Challenger, M.D., 3117 Logan Blvd. Meets at the Palmer House on the second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Earl E. Barth, M.D., 303 E. Chicago Ave., Chicago.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Joseph C. Bell, M.D., 402 Heyburn Bldg., Louisville. Meeting annually in Louisville, third Sunday afternoon in April.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, W. R. Harwell, M.D. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

The Kansas City Radiological Society.—Secretary, P. E. Hiebert, M.D., 907 North Seventh St., Kansas City, Kansas. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, Wilbur K. Mueller, M.D., University Club Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, D. A. Dowell, M.D., 816 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Paul C. Swenson, M.D., Presbyterian Hospital, New York, N. Y.

Rochester Roentgen-ray Society.—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, J. E. McCarthy, M.D., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, J. O. Newton, M.D., 13921 Terrace Road, East Cleveland. Meetings at 6:30 P.M. at the Mid-day Club, in the Union Commerce Bldg., on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually. Next meeting at Necho Allen Hotel, Pottsville, May 15-16, 1942.

The Philadelphia Roentgen Ray Society.—Secretary, Barton R. Young, M.D., Temple University Hospital, Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Harold W. Jacox, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Malcolm Mosteller, M.D., Columbia Hospital, Columbia. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—Secretary-Treasurer, L. W. Baird, M.D., Scott and White Hospital, Temple.

VIRGINIA

Virginia Radiological Society.—Secretary, Charles H. Peterson, M.D., 603 Medical Arts Bldg., Roanoke.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Kenneth J. Holtz, M.D., American Bank Bldg., Seattle. Meetings fourth Monday of each month at College Club, Seattle.

WISCONSIN

Milwaukee, Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

Section on Radiology, Canadian Medical Association.—Secretary, W. J. Cryderman, M.D., Medical Arts Bldg., Toronto.

Section on Radiology, Ontario Medical Association.—Secretary, W. J. Cryderman, M.D., 474 Glenlake Avenue, Toronto.

Canadian Association of Radiologists.—Honorary Secretary-Treasurer, A. D. Irvine, M.D., 540 Tegler Bldg., Edmonton, Alberta.

La Société Canadienne-Française d'Eléctrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

ROBB, J. M. Polyostotic Fibrous Dystrophy of Mastoid Complicated by Acute Mastoiditis 626

COATES, G. M., AND KRAUSS, F. Osteoma of the Frontal Sinus 626

SANCHEZ-PEREZ, J. M. Cerebral Angiography 626

TURNER, OSCAR A., AND BRODY, BERNARD S. Retention of Intraventricular Air Following Encephalography: Report of Two Cases of Unusual Duration 627

The Chest

TORBETT, J. WALTER, JR., AND BENNETT, A. C. Esophagopleural Fistula: A Complication of Empyema 627

EDLING, NILS P. G. Aneurysm of an Intercostal Artery with Simultaneous, Sarcomatous Destruction of an Adjacent, Dorsal Vertebra 627

CLARK, K. C., POULSON, K. T., AND GAGE, H. C. Further Experiments in X-Ray Screen Photography (1011 Subjects with Control Direct Radiographs) 627

MARKOFF, N. Tuberculosis in the Army in Active Service; 1939 and Subsequent Years 627

OECHSLI, WALDO R. Tuberculous Tracheobronchitis: Roentgenographic Appearance 628

WESTERMARK, NILS. On Epituberculosis and Lung Atelectasis 628

WESTERMARK, NILS. A Roentgenological Investigation into Traumatic Lung Changes Arisen through Blunt Violence to the Thorax 628

MOERSCH, HERMAN J., AND OLSEN, ARTHUR M. Rôle of Bronchoscopy in the Treatment of Pulmonary Abscess 629

BERG, GUNNAR, AND ZACHRISSON, C. G. Cystic-Lungs of Rare Origin—Tuberous Sclerosis 629

The Digestive Tract

CHRISTIANSEN, HARALD. Brachyesophagus with Dystopic Cardia 629

SCHMIDT, HERBERT W., AND WALTERS, WALTMAN. Diverticula of the Stomach 629

MYHRE, HELGE. On the Significance of Large Niches in the Stomach 630

URQUHART, R. W. I., SINGLETON, A. C., AND FEASBY, W. R. The Peptic Ulcer Problem 630

STEIGMANN, FREDERICK, AND BACH, AMIL C. Peptic Ulcer and Gastroduodenal Fistulae 630

WHITE, C. S., AND COLLINS, J. L. Congenital Duodenal Obstruction 630

LINDGREN, ERIK. An Apparatus for Radiography (of the Duodenal Cap) in Immediate Connection with Radioscopy 630

RENANDER, AXEL. Roentgenologic Features of Tuberculosis of the Rectum 630

RIGLER, LEO G., BORMAN, C. N., AND NOBLE, JOHN F. Gall-Stone Obstruction: Pathogenesis and Roentgen Manifestations 631

CARTER, R. FRANKLIN, DE CHOLNOKY, TIBOR, AND MARKMAN, H. DAVID. Retroperitoneal Multilocular Chylangioma Cyst with Calcification. Report of a Case 631

The Skeletal System

BOZSAN, EUGENE J. Compression of Cancellous Bone. Principal Manifestations in the Head and Neck of the Femur. Treatment by Connecting Drill Channels 631

BARBER, C. GLENN. Open Surgical Reduction of Fracture Dislocation of the Lumbar Spine with Cord or Cauda Equina Involvement 632

KOVEN, B., AND KOVEN, M. T. Osteomyelitis of the Spine Treated with Fusion by Bone Graft 632

HUDSON, ORTHO C., HETTESHEIMER, CARL A., AND ROBIN, PERCIVAL A. Causalgic Backache 632

LINDGREN, E. Myelographic Changes in Kyphosis Dorsalis Juvenilis 632

VAN CREVELD, S., AND SOETERS, J. M. Myositis Ossificans Progressiva 633

HUBENY, MAXIMILIAN J., AND DELANO, PERCY J. Dysostosis Multiplex 633

HIGINBOTHAM, NORMAN L., AND ALEXANDER, STEWART F. Osteopetrosis. Four Cases in One Family 633

KILFOY, EDWARD J. Osteochondritis Dissecans of the Left Elbow 633

LICHT, ERIK DE FINE. On Bipartite Os Naviculare Pedis 633

Obstetrics and Gynecology

SCHWARTZ, FREDERICK L. Uterine Prolapse. An X-Ray Study 634

The Genito-Urinary Tract

WILLIAMS, E. ROHAN. Pyelo-Renal Backflow 634

TENENBAUM, JOSEPH. Hypernephroma Associated with Hyperplasia and Metastatic Carcinoma of the Adrenals 634

RENANDER, AXEL. Another Case of Spontaneous Rupture of the Renal Pelvis 635

RADIOTHERAPY

Malignant Tumors

CUTLER, MAX. Concentration Method of Radiotherapy for Cancer of the Mouth, Pharynx, and Larynx 635

MARTIN, HAYES, AND SUGARBAKER, EVERETT L. Cancer of the Tonsil 635

ROBERTS, FF. Breast Cancer: A Study of the Train of Events Which May Follow Radical Removal and Post-Operative X-Ray Therapy 636

TENZEL, WILLIAM V. Radiation Therapy in Carcinoma of the Lung 636

FRANK, I., LEV, M., AND BLAHD, M. Transitional Cell Carcinoma of the Upper Respiratory Tract 637

SCHINDLER, RUDOLF, STEINER, PAUL E., SMITH, WILLIAM M., AND DAILEY, MORRIS E. Classification of Gastric Carcinoma..... 637
CAMERON, A. L., AND BRESLICH, P. J. Primary Sarcoma of the Stomach..... 637
NORDLANDER, ERIC. Primary Cancer in the Uterus and in the Rectum of the Same Patient: A Study of Twelve Case Histories.. 638
PATERSON, RALSTON. Cancer of the Bladder.. 638
MEYERDING, HENRY W. Benign and Malignant Giant-Cell Tumors of Bone: Diagnosis and Result of Treatment..... 638
BURGER, R. E., AND LEHMAN, E. P. Hodgkin's Disease: Review of Fifty-four Cases..... 639
DENSTAD, TORFINN. Radiosensitivity of the Bone Marrow..... 639
PHILLIPS, RICHARD B. Symptoms and Signs of Metastatic Cancer..... 639
COLLER, F. A., KAY, E. B., AND MCINTYRE, R. S. Regional Lymphatic Metastases of Carcinoma of the Stomach..... 639
BRAUND, RALPH R., AND MARTIN, HAYES E. Distant Metastasis in Cancer of the Upper Respiratory and Alimentary Tracts..... 640
DORN, HAROLD F., AND HORN, JOSEPH I. Reliability of Certificates of Death from Cancer 640

Non-Malignant Conditions

DEKKERS, H. J. N., AND VAN EBBENHORST TENGBERGEN, J. Results of Roentgen Treatment of Spondylosis Rhizomelica (Spondylarthritis Ankylopoietica)..... 640
KORNBLUM, K. Present Status of Roentgen Therapy in Sinusitis..... 641

Dosage

MAYNEORD, W. V., AND LAMERTON, L. F. A Survey of Depth Dose Data..... 641

Radiation Injuries

CONWAY, HERBERT. Surgical Management of Postradiation Scars and Ulcers..... 641
DALAND, ERNEST M. Surgical Treatment of Post-Irradiation Necrosis..... 642
FICHARDT, THEUNIS. X-Ray or Radium Burn.. 642

EXPERIMENTAL STUDIES

WESTERMARK, NILS. Study of the Cardiac Movements Simultaneously Recorded by Roentgen-Cinematography and Electrocardiography..... 642

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Polyostotic Fibrous Dystrophy of Mastoid Complicated by Acute Mastoiditis. J. M. Robb. Ann. Otol., Rhin. & Laryng. 50: 330–335, June 1941.

A case of polyostotic fibrous dystrophy involving the skull and with an associated acute mastoiditis is reported. The patient had been aware of a large mass in the right parieto-occipital area since childhood. On roentgen examination a large bony mass was demonstrated arising from the right occipital ridge posteriorly. The base of this mass had a somewhat cystic appearance. The mastoid showed evidence of invasion and destruction. Fibrocystic changes were present in the left radius and there were slight but similar changes in the right ilium. A diagnosis of polyostotic fibrous dystrophy and acute mastoiditis was made and mastoidectomy was performed. There seemed to be definite evidence in this patient, and in the family history of hyperpituitarism, suggesting a pituitary dystrophy as an etiological factor in this disease. L. W. PAUL, M.D.

Osteoma of the Frontal Sinus. G. M. Coates and F. Krauss. Ann. Otol., Rhin. & Laryng. 50: 450–457, June 1941.

Two cases of osteoma of the frontal sinus are reported. They were similar in that they occurred within the first three decades of life; each patient had large, well developed frontal sinuses; the inter-sinus septum had been destroyed; each produced marked external deformity; the tumors were of the compact variety, sessile, and an integral part of the inner table; the tumor was very large and the anterior table had been reduced to tissue-paper thinness. Reproductions of the roentgenograms are included.

The treatment of osteoma of the sinuses is entirely surgical as soon as there are enough symptoms to warrant a diagnosis and removal. L. W. PAUL, M.D.

Cerebral Angiography. J. M. Sanchez-Perez. Surgery 10: 535–552, October 1941.

The author describes the early experimental work (1926) of Egas Moniz of Lisbon, Spain, in demonstrating the intracranial vascular system. His original injections were done with 6 c.c. of 25 per cent sodium iodide solution, which produced no local or general reactions. At that time injection was done into the common carotid, following temporary ligation of the external and common carotids. In 1931, after having studied more than 50 arteriograms, he tried, first, a 45 per cent solution of abrodil, and later a 25 per cent solution of thorium dioxide. Following this, he abandoned the use of sodium iodide and other substitutes.

The first phlebogram was obtained by accident. The roentgen exposure was delayed and it was observed that the cerebral arteries had emptied and the venous system was filled. Careful study since has shown that there are two distinct phases of venous circulation distinguished by the various venous groups, which are demonstrable roentgenographically.

A complete angiographic study should consist of three parts: arteriography, phlebography of the first phase, and phlebography of the second phase. It requires injection into the common carotid of 18 c.c. of thorotrast. Strict teamwork among the operative team is necessary, as the procedure must be perfectly synchronized to succeed in making a single injection suffice for the three roentgenograms, showing arteries, small veins, and large venous trunks.

Local anesthesia is obtained by injecting about 10 c.c. of a solution of novocain, sulphate of potassium, and adrenalin. Only for very agitated patients or children is general anesthesia necessary. An incision of from 2.5 to 3 cm. is made in the neck parallel to the collar bone, about 3 or 4 cm. above it and about 4 or 5 cm. from the midline, corresponding approximately to the space between the two heads of the sternocleidomastoid. The incision is made through the skin, the subcutaneous tissue, and the platysma, leaving open the small triangle formed by the two fascicles of the sternocleidomastoid and the collar bone. The fascicles of this muscle will spread until the clinoid sheath is exposed and the incision is then separated by retractors. The artery is punctured without opening the fascia of the vascular pocket.

Any apparatus in which three films may be exposed in rapid succession will probably be satisfactory. The x-ray machine is started when the injection begins; at the moment 8 or 10 c.c. have been injected the first film is exposed, two seconds later the second film, and two and a half seconds later the third. As soon as the injection is finished, the needle is removed from the carotid and a wad of gauze is introduced into the bed of the wound. When it is certain that hemorrhage has ceased, the edges of the cutaneous incision are sutured. A surgical dressing terminates the operation.

The description of the normal angiogram is almost too complicated to present in brief. Roughly, it is the image of the internal carotid artery, including the curves of the carotid siphon. In most cases this is a double siphon or curvature. From this emerges the artery of Sylvius, which shortly divides into three branches: the posterior temporal artery, the middle artery, and the posterior parietal artery. From the internal carotid also emerge the choroidal and the ophthalmic arteries. Further on the anterior cerebral artery is shown.

In the first phlebogram there appear the ascending and descending veins and in the second the large venous trunks. The first shows a series of vessels distributed in a radiating form, the volume increasing as the periphery is approached. The second shows the great venous trunks, clearly outlined, including the various sinuses.

In the presence of a *frontal tumor* there is a deviation of the anterior frontal artery, more or less accented according to the size of the tumor. At the same time, modifications of the Sylvian group of arteries is present and occasionally of the carotid siphon itself. In vascular tumors the newly formed vessels are occasionally visible. When intracranial pressure is increased, the upper and lower lateral sinuses are shown to be dilated, especially so on the side opposite the tumor.

Temporal tumors will displace the Sylvian group also. In addition, the location of the tumor will occasion differences of position and form in the arteriogram. There is considerable similarity between arteriograms in the presence of low temporal lobe tumors and acoustic nerve tumors of sufficient size.

With *parietal tumors* the carotid siphon preserves its normal position; the ascending frontal and Sylvian group show no change in relationship. On the contrary, the pericallosum and marginal callosum are usually displaced downward, forming a curve with the concavity upward. This is just the opposite of the normal curve of these arteries.

In the presence of *aneurysm*, the arteriogram images usually show no alteration in shape or position, except for the vessel in which the tumor is located. Nevertheless, all the arteries present a curious tortuosity.

Occipital lobe tumors are recognized by a displacement of the posterior third, and occasionally the middle third of the Sylvian group, which adopts an oblique position due to upward displacement of the posterior ends. Tumors in this region usually produce compression of the torcular Herophili.

It has been noted that: (1) the speed of the circulation of the blood through the capillary arteries and cerebral veins is two seconds; (2) the speed of the circulation of the blood from the internal carotid artery to the internal jugular veins is four or more seconds; (3) the speed of the circulation of the blood in the arteriovenous territory from the external carotid to the external jugulars is from five to six seconds; (4) the meningeal circulation is perceptibly the slowest of all those dependent on the external carotid. It is a known and proved phenomenon that pathologic conditions considerably alter the cerebral circulation.

JOHN E. WHITELEATHER, M.D.

Retention of Intraventricular Air Following Encephalography: Report of Two Cases of Unusual Duration. Oscar A. Turner and Bernard S. Brody. Am. J. Roentgenol. **46:** 324–328, September 1941.

It is generally accepted that, normally, air introduced into the ventricles is practically all absorbed within 72 hours. With dilated ventricles where a correspondingly larger amount of air has been used, the absorption is less rapid. The present report is of two unusual instances in which air introduced through the lumbar subarachnoid space was visible roentgenographically in the ventricles nine and four weeks later. In both cases inhalations of oxygen caused relative increase in the absorption and some alleviation of the symptoms.

Fine and his associates (Ann. Surg. **107:** 1, 1938) are quoted as stating that "when atmospheric air accumulates in excessive quantities in body cavities or tissue spaces it may become a noxious foreign body. . . ." Boothby and Lovelace are cited as giving good accounts of the use of oxygen therapy (Proc. Staff. Meet., Mayo Clinic **13:** 641, 646, 1938). S. M. ATKINS, M.D.

THE CHEST

Esophagopleural Fistula: A Complication of Empyema. J. Walter Torbett, Jr., and A. C. Bennett. Am. J. Surg. **52:** 129–132, April 1941.

Esophagopleural fistula usually has its origin within the esophagus. In the case here reported the fistula was due to a purulent pleural infection. Perforation of the esophagus was revealed by the appearance of food particles on aspiration of the empyema cavity, and confirmed by fluoroscopy. Tube feeding was instituted and prompt healing of the fistula ensued.

In a review of the literature the author could find only 12 similar cases and these he presents in tabular form. Most of the patients were children. His own was a woman of thirty.

Aneurysm of an Intercostal Artery with Simultaneous, Sarcomatous Destruction of an Adjacent, Dorsal Vertebra. Nils P. G. Edling. Acta radiol. **22:** 411–421, May 1941. (In English.)

Roentgen examination of a forty-six-year-old man complaining of dull abdominal pain under the right costal arch, radiating to the back and up under the right shoulder, suggested the presence of a primary tumor within the right lung with metastasis in the ninth thoracic vertebra, or of a neurinoma growing from the spinal canal (an hour-glass tumor). A sharply defined shadow the size of an infant's head was seen in the lower portion of the right pulmonary field adjoining the heart shadow. It could not be projected free from the spinal column, and in the lateral view it was situated, dorsally, close to the posterior wall of the thorax. On the other hand, it was separated from the diaphragm, which showed normal mobility. The center of the shadow was on a level with the ninth dorsal vertebra, which showed signs of destruction, especially on the right side, where an irregular area of rarefaction the size of a hazelnut was also detected. The contours of the right pedicle were obliterated.

Autopsy revealed an aneurysm, "very likely originating from an intercostal artery," and sarcomatous destruction of the ninth thoracic vertebra. A healed endocarditis was present which might account for the aneurysm. There was no history of trauma, but the author suggests this possibility as offering the only explanation which would account for both the aneurysm and the sarcoma.

This case illustrates the difficulty of correctly diagnosing rounded shadows in the thorax. The extreme rarity of an aneurysm arising from an intercostal artery and the considerable extent of the area of density explain why a correct diagnosis was not suspected from the roentgen examination. No abrasion of the spinal column or ribs could be seen, and the destruction of the vertebral body rather increased the difficulty of interpreting the findings.

Further Experiments in X-Ray Screen Photography (1011 Subjects with Control Direct Radiographs). K. C. Clark, K. T. Poulson, and H. C. Gage. Brit. J. Radiol. **14:** 250–254, July 1941.

In continuation of earlier studies (Clark *et al.:* Brit. J. Radiol. **14:** 654, 1941. Abst. in Radiology **37:** 654, 1941), miniature films (35 mm.), by the photographic method, and standard x-ray studies of the chests of 1,011 subjects were made, and interpretations on both by two observers were compared. In the entire group there were 55 positive findings. Thirteen cases of active tuberculosis were discovered. None of these was overlooked on the miniature films.

Discrepancies between the findings from the miniature films and standard films were 10 for one observer and 11 for the other. For the less experienced reader there were 7 discrepancies in the first 300 read and for the experienced reader only 3 in the first 300, which indicates that experience is essential for accuracy.

Determination of the exposure by the thickness of the chest proved the most accurate, determination by the judgment of the radiographer second, and by the weight of the subject the least accurate.

Projection and enlargement of the miniature films to 8 × 10 inches gave the best visualization with the least fatigue. With enlargement to 4 × 5 inches the brilliance and detail were comparable to those with 4 × 5-inch films.

This study indicates that x-ray screen photography with miniature films, with proper technic, approximates, if it does not equal, in accuracy the direct method with standard films. The radiologist should have experience with about 500 cases to obtain the requisite degree of skill. SYDNEY J. HAWLEY, M.D.

Tuberculosis in the Army in Active Service; 1939 and Subsequent Years. N. Markoff. Schweiz. med. Wchnschr. **71:** 1420–1425, Nov. 8, 1941.

The author considers the differential diagnosis of pulmonary infiltrates with special reference to differentiating non-tuberculous conditions. The group studied forms a special one, as the ages fell mostly between twenty and thirty-five years. Five typical syndromes are considered.

(*1*) *Picture of Hemorrhagic Tracheobronchitis:* In this class belong numerous cases of influenza. Bang's disease leads to a stubborn tracheobronchitis and carries a 3 to 5 per cent mortality; in epidemics it may rise to 14 per cent. Pulmonary bleeding and an upper lobe bronchitis are characteristic of this condition. Rarely this picture may be produced by fusospirochetal infection.

(*2*) *Picture of Hilus Disease:* Hilus tuberculosis must be distinguished from the sequelae of pneumonia, in which one finds large, poorly defined hilus shadows with increased streaking into the lungs and catarrhal

manifestations. Boeck-Besnier-Schaumann's disease or benign lymphogranulomatosis also falls in this group; the characteristic findings should permit the diagnosis if it is kept in mind. In uveoparotid fever of Herfordt one finds paralysis of the cranial nerves and enlargements of the hilar nodes. Swelling of the parotid gland and the lymph nodes, miliary infiltrations in the lungs, enlargement of the liver and spleen, cutaneous changes, a negative tuberculin test, monocytosis, good general condition, normal temperature, and the final development of osteitis cystica complete the picture. Bang's disease may produce hilus enlargement also.

(3) *Picture of Unresolving Pneumonia with Lobar Infiltrate as a Roentgen Finding:* The group of diseases considered under this heading is a varied one and leads to much confusion. Frequent negative sputum examinations are necessary to rule out tuberculosis. A large number of cases of influenza fall into this group. Sometimes sinus drainage leads to this picture. In two locations special considerations arise; if there is a triangular infiltrate in the right paracardiac region, atelectasis of the right inferior accessory lobe, bronchiectasis with pneumonia, and mediastinal pleurisy must be differentiated; in the presence of infiltrates near the cardiac apex influenzal pneumonia with a long drawn-out course, with most of the changes behind the heart, and an atelectasis of the left inferior accessory lobe must be considered. Wassermann-positive lung infiltrates, characterized by irregular, cloudy-streaky-spotty infiltration without specific localization, with a clinical picture of bronchitis, elevated sedimentation rate, massive leukocytosis with a shift to the left, afebrile or subnormal temperature, and a strongly positive syphilitic reaction are thought to be due to the Pfeiffer bacillus. Bang's disease with peri-hilar infiltrate or with pneumonia, actinomycosis, pulmonary lymphogranulomatosis, and pulmonary cancer are also to be thought of here.

(4) *Picture of Mild Bronchitis with Massive Roentgen Findings:* Here are to be considered the fugitive eosinophilic lung infiltrate of Löffler, fugitive node swellings, and focal atelectasis, which may closely mimic a bronchopneumonia.

(5) *Picture of Afebrile Pleurisy:* A not infrequent finding here is spontaneous pneumothorax. In only 1 of 8 such instances observed by the author was there a tuberculous background. Many of these patients can be rehabilitated for military service, but more go into a chronic state of pneumothorax.

In conclusion, a careful differential diagnosis is required to determine the proper course to follow and the propriety of further service. LEWIS G. JACOBS, M.D.

Tuberculous Tracheobronchitis: Roentgenographic Appearance. Waldo R. Oechsli. Am. J. Roentgenol. **46:** 312–320, September 1941.

On the basis of a study of several hundred proved cases of tracheobronchitis due to tuberculosis and correlation with bronchoscopic and autopsy findings, roentgen appearances are described which are considered characteristic of this pathological entity, which complicates about 15 per cent of all far-advanced cases of tuberculosis.

Tuberculous involvement of the bronchi or trachea in most instances follows cavity formation in the lung. Probably the chief method of origin is by direct extension from the pyogenic membrane of the cavity along the bronchus.

The roentgen findings are of two types, direct and indirect. The direct evidence results from pathologic changes in the air passages, while the indirect results from conditions secondary to bronchial pathology.

Under *indirect evidence,* the author discusses (1) localized emphysema, occurring more frequently in the upper lobes; (2) atelectasis of either part of a lobe or whole lobe, or even an entire lung; (3) balloon or tennis-ball cavities, that is, cavities that are round or smoothly oval, frequently showing a fluid level and presenting an appearance of distention; (4) sudden disappearance of a cavity, due to complete stenosis of the bronchus draining it; (5) re-opening of a cavity, due to change in the draining bronchus; (6) unexplained spread of infiltration, which may be a result of aspiration of purulent material from bronchial or tracheal ulcer.

Direct evidence includes (1) encroachment on the lumen of a bronchus, seen best in the larger bronchi; (2) encroachment on the lumen outlined by a contrast medium, as iodized oil; (3) thickening of the bronchial wall, revealed under certain favorable conditions by two white lines separated from each other by a dark shadow representing the lumen.

S. M. ATKINS, M.D.

On Epituberculosis and Lung Atelectasis. Nils Westermark. Acta radiol. **22:** 501–510, September 1941.

Since Eliasberg and Neuland introduced the term "epituberculosis" for a certain pathological condition in children manifesting itself in more or less lobar pulmonic consolidations, opinions regarding the significance of the disease have been divided. Three theories have been most universally accepted: (1) that the radiographic opacities are caused by tuberculous parenchymatous infiltrations; (2) that the opacities are due, wholly or in part, to obstructive atelectasis; (3) that the opacities are due to focal reaction resulting from excessive sensitiveness.

Roentgenologically, two conditions have been described as "epituberculosis." The first condition shows, in addition to the massive pulmonary opacities, retraction of the thoracic wall of the affected side, with displacement of heart and mediastinum toward the same side. This appearance is due to lobar obstructive atelectasis. Judging by autopsy findings, these changes are due to enlarged and caseating hilar lymph nodes either infiltrating or compressing the bronchus leading to the opaque region.

In the second condition, retraction of the chest wall and the mediastinal displacement to the affected side are absent and there may even be expansion of the chest wall and mediastinal displacement to the healthy side. This condition corresponds to the typical picture of Eliasberg-Neuland "epituberculosis," where the opacity is largely due to tuberculous changes of predominantly proliferative type.

The prognosis differs materially in the two conditions. In the obstructive atelectatic type the prognosis is relatively good *only* if the disease is of fairly short duration. If the obstructive atelectasis persists for a longer time, the outlook is unfavorable. In true epituberculosis (Eliasberg-Neuland type), on the other hand, the prognosis is decidedly good. The massive atelectases either disappear entirely or leave only insignificant calcifications. Bronchiectasis, however, must be considered among the sequelae.

In rare instances, a combination of the two conditions occurs. Among 44 cases described as epituberculosis in the medical literature, 7 presented the aspects of obstructive atelectasis. A similar case of the author's own observation is discussed in detail.

E. A. SCHMIDT, M.D.

A Roentgenological Investigation into Traumatic Lung Changes Arisen through Blunt Violence to the Thorax. Nils Westermark. Acta radiol. **22:** 331–346, May 1941. (In English.)

Traumatic pulmonary changes following blunt violence to the thorax may be produced by direct involvement of the lung or pleura, as when these are lacerated by a fractured bone, or they may occur, without any

such obvious injury, following sudden compression of the lung producing rupture of the bronchi or alveoli and consequent hemorrhage of greater or less extent, or even as the result of embolism.

Because of the absence of clinical symptoms, traumatic lung changes arising from blunt violence often go unrecognized, though they are a frequent factor in the causation of pulmonary and bronchial infections, as bronchitis, pneumonia, pleurisy, etc. Early diagnosis, which is possible roentgenologically, is important if such complications are to be prevented, as well as from a medicolegal standpoint.

The author's study is based on 124 cases, of which 64 showed no evidence of fracture, while 56 showed fracture of the ribs, 3 fracture of the sternum, and 1 a fracture of a thoracic vertebra. In 94 cases, including 52 with and 42 without signs of fracture, changes in the lungs were demonstrable roentgenographically.

The changes in the cases associated with fracture included pneumothorax, hemothorax, and intermuscular and subcutaneous emphysema of the thoracic wall, as well as irregular opacities within the lung tissue situated peripherally and localized close to the fracture site. In the cases without fracture there were mottled densities spread over the greater part of the lung, streaky and patchy infiltrations along the larger and medium-sized bronchi and blood vessels, large irregular opacities in the central parts of the lung, massive wedge-shaped opacities in the distribution of some particular bronchial branch (obstructive atelectasis), and interstitial emphysema.

It is rare for the traumatic lung changes to be of one type only. In most cases there is a combination of two or more different types of traumatic change. This is of great value in the differential diagnosis.

Uncomplicated traumatic changes in the lung usually clear up promptly—within two or three weeks. Complications, however, are of not infrequent occurrence. Acute bronchitis occurred in 28 of the author's series, or 23 per cent, pneumonia in 12 cases, or 10 per cent.

Rôle of Bronchoscopy in the Treatment of Pulmonary Abscess. Herman J. Moersch and Arthur M. Olsen. Surgery **9:** 905–915, June 1941.

This study is based on 264 cases of putrid pulmonary abscess seen at the Mayo Clinic over a fourteen-year period, 193 of which were treated bronchoscopically. Cases which occurred in association with tuberculosis, bronchiectasis, tumor, or aspirated foreign body are not included. The authors state that the procedure is of value only in cases in which the abscess communicates with a bronchus, and that, if a communication exists and drainage is adequate, spontaneous resolution will generally take place.

If benefit is to be derived from bronchoscopic aspiration, it is important that the bronchus leading to the abscess be thoroughly dilated. Aeration is especially important, since it has been demonstrated that anaerobic organisms are found in approximately 80 per cent of the cases. The authors have often been able to place an aspirating tube directly into the abscess cavity.

It has frequently been stated that a pulmonary abscess which has been treated successfully by bronchoscopic drainage will often recur after the treatment has been discontinued. That did not prove to be true in this series of cases.

The incidence was found to be three times as high in men as in women. Abscesses were seen at all ages, but the maximum number occurred in the fifth decade. It is interesting that cases following surgical procedures approximately equaled non-operative cases. Tonsillectomy was the most frequent etiological factor in this series and in the group due to that cause 90 per cent followed general anesthesia.

The location of pulmonary abscess is of the utmost importance in determining whether or not bronchoscopy is advisable. The right lung was the most frequently involved, and the lower lobe was the most usual site. The right upper and the left lower lobes were next most frequently implicated.

In order to evaluate properly the results of treatment, it is necessary to observe the patient over a long period of time. A single bronchoscopic aspiration may lead to striking improvement, but it has been shown that even if the abscess appears clinically and radiographically healed, an abscess cavity may still be demonstrable after instillation of iodized oil. More than 60 per cent of the patients of the series reported obtained satisfactory results from bronchoscopic drainage, and the results obtained in later years were very little better than those in earlier years. Mortality has been less than 5 per cent. Over half of the deaths were due to empyema associated with the abscess.

The most important deciding factor in the prognosis is the duration of the abscess before treatment, whether surgically or bronchoscopically. When the abscess had been present less than four weeks 89 per cent of the patients responded satisfactorily. In cases of four weeks' but less than three months' duration, the figure dropped to 69 per cent. The authors do not approve of repeated and indiscreet bronchoscopic aspiration, but advocate prompt surgical intervention if two or three aspirations fail. JOHN E. WHITELEATHER, M.D.

Cystic-Lungs of Rare Origin—Tuberous Sclerosis. Gunnar Berg and C. G. Zachrisson. Acta radiol. **22:** 425–436, May 1941. (In English.)

Two cases are recorded of tuberous sclerosis, in sisters, with an associated cystic degeneration of the lungs, proved in one instance at autopsy. A thirty-year-old male with diabetes insipidus showed similar roentgen findings. These consist of an "irregular, honeycomb-like pattern made up of scarcely visible to hazelnut-sized translucencies, separated by fine round striae over both lung fields. These markings seem to become less dense at the apex at the same time as the cavities appear to increase somewhat in size, probably due to the upward decreasing thickness of the lung tissue (wedge effect). The points of intersection in the honeycomb structure do not show any particular tendency to mottling, although the picture on the whole resembles that seen in different forms of miliary dissemination."

THE DIGESTIVE TRACT

Brachyesophagus with Dystopic Cardia. Harald Christiansen. Acta radiol. **22:** 360–366, May 1941. (In English.)

Four cases are recorded of congenital short esophagus with the cardia in the thoracic cavity. Two of the patients were infants and two were adults. The author accepts Tonndorf's explanation of this anomaly as due to deficient growth of the esophagus (Deutsch. Ztschr. f. Chir. **179:** 259, 1923). There may be some constriction of the cardia due to its abnormal position. In the author's two younger patients, vomiting was the chief symptom: in one there was hematemesis, which is attributed to "incarceration of the stomach in the muscularized part of the diaphragm." Treatment is symptomatic, including dilatation of the stenosis. [This subject was recently reviewed by H. F. Polley (J. A. M. A. **116:** 821, 1941. Abst. in Radiology **37:** 387, 1941).]

Diverticula of the Stomach. Herbert W. Schmidt and Waltman Walters. Am. J. Surg. **52:** 315–318, May 1941.

False diverticula of the stomach may develop secondary to a perforating ulcer or an ulcerating carcinoma. Gastroscopy is of special aid in differentiating these from true, or congenital, diverticula.

The orifice of a true diverticulum has the appearance of a circular hole. The margins are rounded and sharply defined. The surrounding mucosa may be entirely normal. There is no sign of infiltration at any point. A penetrating gastric ulcer, on the other hand, usually has a base which is covered with a gray or white exudate or, more rarely, with blood. The surrounding mucous membrane is quite apt to show evidence of an associated inflammatory reaction. A penetrating carcinoma shows signs of ulceration in the base of the sac, and the surrounding margins are irregular and infiltrated.

Two cases are recorded: one of true and one of false diverticulum.

On the Significance of Large Niches in the Stomach. Helge Myhre. Acta radiol. **22:** 482–489, September 1941. (In English.)

Basing his conclusions on 23 cases observed at the Oslo University Clinics, Myhre critically analyzes the radiological and operative findings with regard to the significance of large niches of the stomach. He found that 14 niches were due to benign ulceration, while 9 were caused by cancer. In his study he has considered only niches with a diameter of 2.5 cm. or above, since niches of such size, as a rule, raise the suspicion of malignant growth.

Myhre's findings do not confirm the frequently reported relationship between size of niche and malignant character, as some of his largest niches proved to be of benign origin. The measurements of the 14 benign niches ranged from 2.5 cm. to 6.5 cm. (the majority varying from 3 to 4.5 cm.), while the size of those due to malignant ulcers was between 2.5 cm. and 4.5 cm. Myhre concludes, therefore, that, contrary to the prevalent opinion, large niches may just as often represent benign lesions as cancer, if not oftener.

Emphasis is laid on the difference in radiographic and surgical measurements, which is explained by the enlargement seen in the roentgenogram. The differential diagnosis between benignity and malignancy may be extremely difficult, if not impossible, in some cases. Even temporary improvement may be misleading and does not exclude a malignant tumor.

E. A. SCHMIDT, M.D.

The Peptic Ulcer Problem. R. W. I. Urquhart, A. C. Singleton, and W. R. Feasby. Canadian M. A. J. **45:** 391–395, November 1941.

The authors report on their study of the peptic ulcer problem at the 15th Canadian General Hospital in England. They point out that, although the percentage of patients reporting to a general hospital with symptoms referable to the upper gastro-intestinal tract is small, there is still a relatively high percentage of wastage in the Canadian Forces overseas due to gastric or duodenal ulcer.

The duration of the presenting symptoms in the series recorded—377 cases—varied from a few days to seven months. In one-half of the cases with a pre-war history suggestive of ulcer, the average duration of the present symptoms was three months. In 90 per cent of a small group of men without any preceding history of gastro-intestinal disturbances, symptoms developed within the first six months of service in England. Change from home to mass cooking and separation from home and family are mentioned as possible causative factors in such cases.

In army practice radiological support of ulcer diagnosis is essential. The only acceptable radiological evidence of ulcer is the demonstration of the ulcer crater.

A small group treated with aluminum hydroxide did not do so well as those on routine treatment. Rigid control of smoking appeared to be of definite value. Because of the high percentage of relapse in cases of duodenal ulcer, it is suggested that all such patients be invalided from services in England.

The authors add a note on the large number of functional dyspeptics coming to the hospital, especially in the winter months. Few of these developed organic disease and it is recommended that they be kept on active service. M. L. CONNELLY, M.D

Peptic Ulcer and Gastroduodenal Fistulae. Frederick Steigmann and Amil C. Bach. Am. J. Surg. **52:** 355–359, May 1941.

Two cases are recorded of non-carcinomatous gastroduodenal fistula, a condition which, though of unusual occurrence, should be borne in mind by the surgeon and roentgenologist. Since diagnosis cannot be made clinically, dependence must be placed largely upon the roentgen examination, though in some cases the final decision must be reserved until operation.

In the first of the cases reported here the roentgenogram showed the pyloric portion of the stomach and the duodenal bulb apparently opening from the lesser curvature "as if the patient may have had a penetrating ulcer on the lesser curvature of the stomach which had perforated into the duodenum." The roentgenogram in the second case showed a large niche on the lesser curvature of the pars media but did not reveal the fistulous communication, which was discovered at autopsy.

Congenital Duodenal Obstruction. C. S. White and J. L. Collins. Arch. Surg. **43:** 858–865, November 1941.

Obstruction in the duodenum of the newborn may be extrinsic, due to adhesions, or intrinsic, due to a congenital septum or diaphragm or to failure of development of a lumen. Symptoms are those of obstruction, but differ from the symptoms of pyloric hypertrophy in that bile is usually present in the vomitus. Study by x-ray both with plain films and with barium to localize the obstruction is highly advisable. The treatment is immediate operation. Temporizing to administer fluid or blood does more harm than good; they may be given just before operation if no time is lost thereby. The condition carries a high mortality, but under prompt surgical management this can be materially reduced. LEWIS G. JACOBS, M.D.

An Apparatus for Radiography (of the Duodenal Cap) in Immediate Connection with Radioscopy. Erik Lindgren. Acta radiol. **22:** 383–386, May 1941. (In English.)

An apparatus is described for serial exposures of the duodenal cap in immediate connection with fluoroscopic study. Its essential features are a lead plate, with an aperture measuring 9 × 12 cm., which replaces the ordinary fluoroscopic screen, and a special cassette changer provided with 2 magazines for cassettes with a fluoroscopic screen between them. The cassette changer is so fixed to the lead plate that the screen comes over the aperture in the latter. By operation of a handle a cassette is brought into position for exposure, following which it is shifted to the opposite magazine, leaving the apparatus in position for screening. The services of an assistant are required, as the exposures cannot be made automatically, but this the author considers no great drawback.

Roentgenologic Features of Tuberculosis of the Rectum. Axel Renander. Acta radiol. **22:** 367–370, May 1941. (In English.)

A case of tuberculosis, presumably primary in the rectum since there was no evidence of pulmonary disease, is recorded, with special attention to the roentgenologic features distinguishing it from cancer and syphilis. For the most part these various condi-

tions are accessible to digital and proctoscopic examination and the findings thus obtained, with the possible addition of biopsy, may be all that is necessary for the diagnosis. In an occasional case roentgen examination may add useful information. The author summarizes the situation as follows: "When faced with clinically unclear cases of organic changes in the rectum, the roentgenologist should have tuberculosis in mind, and suspect its presence if the muscularis propria has any of its contractility left when the intestine shows annular organic stricture, and his suspicions should grow stronger the greater the discrepancy between extensive organic changes and good contractility."

Gall-Stone Obstruction: Pathogenesis and Roentgen Manifestations. Leo G. Rigler, C. N. Borman, and John F. Noble. J. A. M. A. **117:** 1753–1759, Nov. 22, 1941.

Gallstone ileus is one of the conditions in which such temporizing procedures as suction decompression of the bowel are not indicated. Diagnosis of dynamic ileus due to gallstones can, in most instances, be determined by means of roentgen examination.

Intestinal obstruction due to gallstones has been indicated by various authors as ranging from 1.4 to 5 per cent of all cases of bowel obstruction. Gallstones may enter the intestinal tract either through an internal biliary fistula or through the common duct. Stones large enough to cause obstruction almost always enter through a true internal biliary fistula. The most frequent of such communications is between the gallbladder and the duodenum. Next in frequency as a source of gallstone obstruction is the choledochoduodenal fistula. In such cases the common duct may be massively dilated. Whether a stone entering the bowel through the ampulla of the common duct can produce obstruction still remains a matter of conjecture. Such cases have been reported but there is a question as to whether most of these are not in fact cases of communication through choledochoduodenal fistulas located near the end of the duct.

It can be stated with considerable certainty that most stones producing occlusion enter the small bowel directly from the fundus of the gallbladder. Stones entering the colon directly seldom produce frank obstruction. Regurgitation of air or barium through the fistula into the biliary radicles permits visualization of the biliary tree.

Most writers agree that a stone measuring more than 25 mm. in diameter is not likely to pass through the small bowel without producing symptoms. In the majority of instances the terminal ileum is the final site of impaction. The finding of a faceted stone implies the distinct possibility of the presence of a second stone, for which a search should be made.

The clinical features of gallstone ileus are almost always misleading. Probably 75 per cent of the patients are women over 60 years of age.

The roentgen examination in cases of intestinal obstruction from a gallstone may reveal any or all of the following signs: (1) air or contrast medium in the biliary tract; (2) direct visualization of the stone or indirect visualization of the stone by means of contrast medium in the intestine; (3) change in position of a previously observed stone; (4) the roentgen evidences of partial or complete intestinal obstruction.

The recognition of air or contrast medium in the biliary tract will indicate the nature of the obstructing lesion in a higher percentage of cases than any other single sign. Gallstones that have entered the gastrointestinal tract and which are large enough to produce obstruction practically always leave a pathway behind them permitting reflux of intestinal content. Films should be made in anteroposterior and postero-anterior projections, centered over the right upper quadrant.

Rarely barium may enter the distal ends of the ducts in pancreatitis. Indurating lesions adjacent to the common duct, usually malignant, are also known to have permitted reflux. Emphysematous cholecystitis and cholangeitis incident to infections of the biliary tract with gas-forming organisms may occasionally produce gas in the ducts. With these possible exceptions, the presence of contrast material or gas in the biliary tract is synonymous with fistula formation. In a certain percentage of cases, the stone will be seen in the roentgenogram of the abdomen. Administration of barium as an aid is not recommended. Biliary calculi are most likely to be found in the region of the terminal ileum.

The roentgen evidences of intestinal obstruction are obviously also to be found. Characteristic distention of loops of the small bowel, however, may not be demonstrable because the obstruction may be only partial or intermittent.

In all of the 14 cases of gallstone obstruction examined or observed by the authors there were reasonably good roentgen signs of intestinal obstruction; in all but one there was evidence of gas or contrast medium in the biliary tract. The calculus was directly demonstrable in four cases and showed a change in position from its previously known site in two cases. In one case the calculus produced a defect in the barium-filled intestinal shadow. It should be noted that while the diagnosis was not made in all these cases from the roentgen examination, this was not due to the absence of signs in the roentgenogram.

The authors state in their summary that it is important to recognize the exact nature of an obstructing lesion of the bowel in order to determine whether suction therapy or immediate surgery should be undertaken. Because gallstone obstruction is an indication for immediate intervention, every effort should be made to recognize its characteristic roentgen signs.

Case reports and illustrations are given to demonstrate the diagnostic signs set forth by the authors.

CLARENCE E. WEAVER, M.D.

Retroperitoneal Multilocular Chylangioma Cyst with Calcification. Report of a Case. R. Franklin Carter, Tibor de Cholnoky, and H. David Markman. Am. J. Surg. **52:** 338–345, May 1941.

An example is recorded of retroperitoneal multilocular chylangioma with calcification in a five-year-old girl. The chief symptoms were jaundice and abdominal pain, but no mass was palpable and laboratory studies were largely negative. Roentgen study, however, made possible a diagnosis, and operation was followed by recovery.

The cyst was demonstrable in routine flat roentgenograms as a circumscribed shadow in the left iliac region, situated rather posteriorly in the abdomen. Intravenous urography showed the mass in relation to the left ureter and suggested its retroperitoneal location, while retrograde pyelography established the fact that the kidneys were uninvolved and examination following a barium enema showed the lesion to be outside of the colonic tract.

The literature is reviewed and a bibliography is appended.

THE SKELETAL SYSTEM

Compression of Cancellous Bone. Principal Manifestations in the Head and Neck of the Femur. Treatment by Connecting Drill Channels. Eugene J. Bozsan. Am. J. Surg. **53:** 541–618, September 1941.

In this monograph the author lists as manifestations of compression of cancellous bone in the head and neck of the femur, osteochondritis dissecans of the head of the femur, the several forms of coxa vara, Waldenstroem-Legg-Calvé-Perthes' disease, the slowly slipping and the acutely slipped upper femoral epiphysis,

and the deforming process subsequent to congenital dislocation of the hip. Other conditions based on the same pathogenic principle include osteochondritis of the acetabulum, acetabular Perthes' disease, ischiopubic osteochondritis, osteochondritis of the symphysis, and the so-called adolescent sacro-iliac syndrome.

A study of the early literature—to which considerable space is devoted—shows that these conditions were well known and accurately described before the period of roentgenography. The common factor, or connecting link, among them is the aseptic necrosis of the bone involved—the "quiet necrosis" described by Teale in 1856 and Paget in 1875.

No satisfactory theory for the origin of this aseptic necrosis has been advanced, but the author believes he has found the true explanation. "If cancellous bone is subjected to force which is greater than its maximum of structural strength, its architecture will collapse. This collapse obeys the laws of mechanics, and the minute girders of the cancellous structure break at places predetermined by these same laws. The broken mass of trabeculae interrupt the flow of blood and cause necrosis of certain, also predetermined segments of bone."

The author describes a method of treatment, based on the tendency to spontaneous healing in these lesions. This consists in the drilling of channels connecting the necrotic segment with adjacent living bone, thereby facilitating the process of natural repair. The result is commensurate with the degree in which new bone is substituted for the necrotic, but the removal of the necrotic tissue is the first postulate. As long as such portions are still present, the disease is at best latent and may flare up any time and lead eventually to arthritis deformans. The newly deposited bone, if injudiciously subjected to weight-bearing and other demands, may in its turn collapse and give the disease a new start. It should be carefully protected.

The paper concludes with a series of case reports and an extensive bibliography.

Open Surgical Reduction of Fracture Dislocation of the Lumbar Spine with Cord or Cauda Equina Involvement. C. Glenn Barber. Am. J. Surg. **52:** 238–245, May 1941.

A case is reported of fracture dislocation of the first and second lumbar vertebrae with an associated paralysis involving the lower extremities. Ankle traction and manipulation a few hours after the injury resulted in a disappearance of the external deformity and some symptomatic relief, while a comparison of roentgenograms taken before and after treatment showed a favorable effect on the compression fracture of the body of the second lumbar vertebra and on the forward displacement of the adjacent bodies. A lateral dislocation of the first on the second vertebra persisted, however, having become securely locked as a result of a change in the positions of the articular processes.

Open reduction was undertaken to correct this. Following this procedure the paralysis gradually disappeared and within a year after the accident the patient had resumed practically all his former activities, although there remained some weakness in the lower left abdominal muscles and areas of hypesthesia in the left inguinal region and about the left knee and toes, while a slight redislocation was observed roentgenologically.

Only one other case of satisfactory open reduction of fracture-dislocation of the spine with involvement of the cord or cauda equina was found in the British and American literature (Rogers, W. A.: J. Bone & Joint Surg. **20:** 689, 1938).

Osteomyelitis of the Spine Treated with Fusion by Bone Graft. B. Koven and M. T. Koven. Am. J. Surg. **53:** 13–31, July 1942.

The authors have seen in a period of ten years 12 cases of pyogenic osteomyelitis of the spine. As in osteomyelitis involving other bones, the infection may reach the spine by direct extension or, more frequently, by way of the blood stream, with ensuing thromboarteritis or capillary thrombosis.

This paper is concerned chiefly with the treatment of the disease by spinal fusion and includes reports of five cases thus treated. Symptoms and diagnosis are discussed briefly, reference being made to Kulowski (J. Bone & Joint Surg. **18:** 343, 1936) for fuller details. Of the roentgen findings the authors say: "In studying these, we must again repeat that acute osteomyelitis of the spine passes through the same stages as osteomyelitis of long bones. These stages are influenced by localization and therapeutic factors. In the presence of pyogenic organisms, one invariably finds roentgenologic evidence of degeneration and proliferation at the same time. Kulowski stresses that the most characteristic feature of pyogenic osteomyelitis is the presence of a reactive new bone formation characterized by spike-like projections from the margins of the affected vertebra. . . . . Telescoping is more frequent in tuberculosis because breaking down of the bodies occurs more extensively in this condition. By contrast with tubercular spondylitis there is a rapid and early involvement of the intervertebral disks in pyogenic infections of the vertebrae."

Causalgic Backache. Ortho C. Hudson, Carl A. Hettesheimer, and Percival A. Robin. Am. J. Surg. **52:** 297–303, May 1941.

From the many forms of backache the authors separate one type which they attribute to muscular imbalance and for which they suggest the qualifying adjective causalgic, because of the burning character of the pain. The patients complain of an upper lumbar backache that is aggravated at rest, awakens them at night, and is accompanied by pain radiating along the last rib and to the groin. Clinical examination reveals an increased lumbar lordosis, postural scoliosis, a pelvic tilt, abduction and rotation of the femur on the side of the low iliac crest, and adduction of the thigh on the opposite side. Tension is increased within the quadratus lumborum fascia, producing direct pressure on the twelfth dorsal and first lumbar nerves, with tenderness and hyperesthesia over their cutaneous distribution.

Roentgenograms of a typical case are reproduced: a supine film showing equal costovertebral angles, negligible deviation of axis of lumbar and level crests and femoral heads; upright film showing acute left costovertebral angle, deviation of lumbar spine toward the right, and low left iliac crest and femoral head; upright film taken with a 1/2-inch elevation under left heel, showing a partial correction of the deformities; upright film with a 3/4-inch elevation under left heel, showing almost complete restitution to normal posture.

Treatment is simple and effective, consisting in elevation of the heel on the side of the low iliac crest and muscle exercises.

Myelographic Changes in Kyphosis Dorsalis Juvenilis. E. Lindgren. Acta radiol. **22:** 461–470, September 1941. (In English.)

In 1928, Jaroschy (Beitr. z. klin. Chir. **142:** 597, 1928) described late pathological changes in the spinal cord in scoliosis. Wretblad, in 1939, extended these investigations to kyphosis, reporting similar findings, for which he suggested the term "late damage of the spinal cord following spinal curvature," as a definite clinico-neurological entity (Acta psychiat. et neurol. **14:** 617, 1939). Following up this previous work, Lindgren examined, by means of myelography, the spines of 8 patients suffering from typical juvenile dorsal kyphosis (Scheuermann's disease). In 4 of the cases only lipiodol was injected, in 2 cases both lipiodol and gas, while in the remaining 2 gas myelography alone was employed. Comparison of the results influenced Lind-

gren in favor of gas myelography, which not only afforded a clearer picture of the anatomical conditions but also tallied better with the clinical observations of block. While often no pathological changes could be seen during lipiodol examination, occasionally a slight retardation of the passage through the subarachnoid space, or a flattening of the subarachnoid space in the kyphotic area became manifest. In lipiodol-gas or gas myelograms the pathological changes were more pronounced, the subarachnoid space appeared narrower and more irregular in outline. At the level of the vertex of the kyphosis it might appear completely compressed. The gradual narrowing of the subarachnoid space in this case is a valuable differential diagnostic point *versus* tumor, where, as a rule, the constriction is more abrupt. If examination of the epidural space is advisable an absorbable contrast medium, as perabrodil, should be employed. The epidural space is widened over the kyphotic area opposite the constricted portion of the subarachnoid space. E. A. SCHMIDT, M.D.

Myositis Ossificans Progressiva. S. van Creveld and J. M. Soeters. Am. J. Dis. Child. **62:** 1000–1013, November 1941.

A case of myositis ossificans progressiva was carefully studied and the progress noted with respect to the clinical, roentgenological, pathological, laboratory, and therapeutic aspects.

The patient was a white female child whose first symptom of the disease was swelling and induration of the subcutaneous tissues and muscles of the neck following otitis media at the age of eighteen months. During an observation period of about five years the process extended to the thorax, arms, abdominal wall, and back.

Roentgenograms showed extraskeletal bone formation, especially along the muscles of the trunk and the upper part of the arms, with development of ramifications and plaques. The formation of bone rather than amorphous calcification distinguished the condition from calcinosis universalis progressiva. The new bone was partially attached to the bones of the skeleton. There were congenital deformities of the great toes, thumbs, and little fingers. Other abnormalities noted were thickening of the frontal bone and osteoporosis in some parts of the skeleton.

Biopsy specimens were studied both histologically and chemically, revealing interstitial myositis and low glycogen and creatinine contents.

Laboratory data included serum phosphatase, calcium and phosphorus balance, excretion of estrogen, and excretion of creatine and creatinine, in addition to the more usual tests. The excretion of calcium was relatively high, but in general none of the findings was conclusive.

The following therapeutic measures were tested: administration of sodium citrate, injection of parathyroid solution, administration of disodium hydrogen phosphate, and a low calcium diet. No clinical or roentgen improvement was obtained by any of these procedures. GEORGE M. WYATT, M.D.

Dysostosis Multiplex. Maximilian J. Hubeny and Percy J. Delano. Am. J. Roentgenol. **46:** 336–342, September 1941.

Dysostosis multiplex is a congenital disease characterized by interference with ossification and leading to degenerative changes in cartilage. The active stage of the dystrophy appears to cease as the time for fusion of the epiphyses and diaphyses approaches, but the pressure deformities remain as evidence that the dystrophy has existed. Prominent among the characteristic lesions are wedge-shaped deformities of vertebrae, failure of appearance of epiphyseal centers and delay in their ossification, shortening of the neck due to cervicodorsal deformity, which also leads to an appearance of a shelf-like protrusion of the upper thorax, and shortness of the trunk as compared with the limbs. Deformities of the skull are variable and inconstant; there may be scaphocephaly or oxycephaly and depression of the bridge of the nose, and corneal opacities are found in some cases. When these skull and eye changes are present, the deformity corresponds more nearly to the type originally described by Hurler (Ztschr. f. Kinderh. **24:** 220, 1920); when they are absent the type falls more readily into the group described by Brailsford (Radiology of Bones and Joints, Baltimore, Wm. Wood & Co., 1935) and Morquio (Arch. de méd. d. enf. **32:** 129, 1929).

Orthopedic management of the deformities is all that has been of service to date. Various approaches through endocrine therapy have been without result. The literature on the subject is extensively covered, differential diagnosis is discussed, and a case is presented.

Osteopetrosis. Four Cases in One Family. Norman L. Higinbotham and Stewart F. Alexander. Am. J. Surg. **53:** 444–454, September 1941.

Four cases of osteopetrosis, marble bones, or Albers-Schönberg's disease, are recorded, bringing the total number of cases in the literature to 135. Sixty-nine cases were collected by McCune and Bradley (Am. J. Dis. Child. **48:** 949, 1934) in 1934. Nussey, four years later (Arch. Dis. Childhood **13:** 161, 1938), brought the total to 112, listing the examples appearing since 1934, and the present paper includes a table showing 19 additional cases from the literature.

The disease is fundamentally a disturbance of normal bone formation characterized by increased density of the cortical and spongy portions of the entire skeletal system. The clinical symptoms are due to secondary pathological changes, but while they may suggest the diagnosis, roentgen examination is necessary to establish it. Characteristic features are the great increase in density of bone shadows, with complete or partial loss of normal osseous structure, and diminution of the marrow cavities. Club-like thickenings of the posterior clinoid processes and narrowing of the sella turcica are common findings. There often may be transverse bands of greater and lesser density parallel to the position of the epiphyseal line in the shafts of the long bones. Overgrowth of the lower jaw was a constant feature in the four cases here reported. Pathological fractures may occur but are not an essential feature; they heal without delay. The great danger lies in bone infection, especially infection of the jaw.

The etiology of osteopetrosis is not known. The familial and hereditary implications of reported series of cases are so striking that it has been suggested that this defect in bone formation may be a mendelian recessive character.

Osteochondritis Dissecans of the Left Elbow. Edward J. Kilfoy. Am. J. Surg. **53:** 496–499, September 1941.

A case is reported of osteochondritis dissecans of the left elbow. Only two other cases of osteochondritis in this site could be found in the literature, though 14 instances were discovered in which the right elbow was involved. As in most cases, there was a history of trauma. The diagnosis was made on the basis of the roentgen findings, showing fragmentation of the head of the radius, with no evidence of callus formation. Surgical removal of the fragments produced an excellent result.

On Bipartite Os Naviculare Pedis. Erik de Fine Licht. Acta radiol. **22:** 377–382, May 1941. (In English.)

The author reports four cases of bipartite navicular bone of the foot and describes the roentgen picture as follows: In dorso-plantar projection one finds on one

side—or often on both sides—of the navicular, a wedge-shaped alteration of the bone, with the base of the wedge directed medially, the point laterally. Lateral to the point of the wedge is an indefinite shadow, representing a small, dorsally situated part of the bone. This shadow is much more conspicuous in a lateral view; it is, as a rule, triangular and may be more or less distinctly separate from the rest of the bone. Usually it is disposed like a wedge, with the point toward the sole; sometimes it is made up of several smaller shadows.

In the cases recorded the main portion of the navicular appeared in the lateral view as an oval, though it may be more angular. The condition was bilateral in two cases; in one case there were moderate uncharacteristic changes in the opposite foot; and in one instance the affection was distinctly unilateral. In all four cases there was an associated arthrosis.

Bipartite os naviculare is to be differentiated from tabes and in the unilateral cases from fracture. In tabes the appearance is more "crumbled" and the affected bones may appear confluent. Comparatively few cases of this anomaly have been published. One by Anspach and Wright appeared in Radiology **29:** 725, 1937.

OBSTETRICS AND GYNECOLOGY

Uterine Prolapse. An X-Ray Study. Frederick L. Schwartz. Am. J. Surg. **53:** 111–116, July 1941.

Because of the difficulty of evaluating degrees of prolapse of the uterus and its rôle in the production of such subjective symptoms as backache, pain on standing, discharge, etc., the author has devised a method for accurately measuring the position and mobility of the organ. This consists in the roentgen demonstration of the cephalad and caudad excursion of an intracervical cannula. Measurements from the upper border of the symphysis pubis to the tip of the cannula give the relative position of the uterus and the exact degree of mobility.

The technic the author describes as follows: "The patient is positioned on the table as for a gynecologic examination, and a tube distance of thirty inches is used. In exposing the cervix a speculum with a divided anterior blade is desirable so that it may later be slipped out of the vagina without disturbing the cervical tenaculum or the cannula. After the desired number of films using varying amounts of contrast media have been exposed, the speculum is removed from the vagina. With the speculum in place there is a certain amount of splinting of the vaginal walls and limitation of motion. Taking care to keep in the long axis of the body, the uterus is pulled as far downward as possible and a film exposed. Next, the procedure is reversed and a film is made with the uterus at the cephalad limit of its excursion. In this maneuver pressure is made on the uterine cannula and the cervix is steadied by the tenaculum. Measurements taken from these two films give the upper and lower limits of motion."

Twenty-five cases were studied by the procedure described. The average mobility in the group without symptoms was 2.6 cm. and the average low above the symphysis was 5.5 cm. In the group with symptoms the average mobility was 5 cm. and the low point above the symphysis 1.2 cm.

The conclusion is reached that a low point less than 3.5 cm. together with mobility greater than 4 cm. indicates uterine relaxation of sufficient degree to produce symptoms.

THE GENITO-URINARY TRACT

Pyelo-Renal Backflow. E. Rohan Williams. Brit. J. Radiol. **14:** 275–283, September 1941.

There are four types of pyelorenal backflow: pyelovenous, pyelolymphatic, pyelotubular, and pyelointerstitial. The form which the backflow takes depends upon whether or not there is rupture of a calyx. The only kind which can occur without a rupture is pyelotubular. Backflow may be initiated with pressures as low as 20 mm. Hg, but usually does not occur until the pressure reaches 40–60 mm. Hg.

It is not settled whether or not backflow occurs normally. It seems likely that it does take place in the presence of a ureteral obstruction with hydronephrosis. With obstruction, absorption from the pelvis may occur *via* the tubules or lymphatics.

All forms of backflow are met with in pyelography, though the interstitial and lymphatic types are rather uncommon. Pyelovenous backflow is recognized in its earliest stages by a streak of opaque medium passing out from the calycine angle, usually at a right angle to the long axis of the minor calyx, and curving around toward the cortex of the kidney in the interlobar veins. The pyelotubular type is evident in a fanwise streaking of fine linear radiations of the opaque material from the papillary region of a calyx. It would appear to have no significance, providing a non-toxic substance is used as the contrast medium. The pyelo-interstitial type, or true extravasation, occurs only as a result of roughness in technic. It may be seen in association with venous backflow as an ill-defined smearing of the opaque medium into the juxta-calycine region, or after forced injection as a blotchy formless opacity, extending outward from a calyx, or as a straight streak into the medullary tissue. The extravasation may even reach the subcapsular zone. Pyelolymphatic backflow is observed only rarely and suggests that some abnormal communication is present, either congenital or acquired, between the lymphatic channels and the pelvis and calyces. It occurs especially in association with chyluria and may be recognized by the visualization of one or more channels coursing from the region of a minor calyx across the pelvis in the direction of the spine over the psoas muscle.

Backflow is more apt to occur when the pelvis is filled with the pressure syringe method, but may occur with gravity filling. Care should be taken to avoid this if possible. Toxic substances should not, of course, be used as contrast media. Hemorrhage following pyelography may be accounted for by slight rupture of the mucosa from pressure.

The historical background of pyelorenal backflow is extensively covered. SYDNEY J. HAWLEY, M.D.

Hypernephroma Associated with Hyperplasia and Metastatic Carcinoma of the Adrenals. Joseph Tenenbaum. Am. J. Surg. **52:** 120–128, April 1941.

The case here recorded the author describes as "something of a pathologic museum incorporated in a single body." The patient was a woman of 37, married but childless, whose chief complaints were hematuria and general weakness. She had experienced a considerable loss of weight during the past year and suffered occasional attacks of renal colic and bladder distress followed by the passage of large blood clots. A pronounced hypertrichosis was present, the skin was dry and inelastic, and the breasts were atrophied. A nodular mass was palpable in the right upper quadrant of the abdomen.

Roentgen studies showed a large staghorn calculus in the left kidney and a soft indefinite mass on the right side with no psoas markings. Following intravenous urography no dye appeared in the right kidney one hour after injection of diodrast. On retrograde pyelography this kidney appeared greatly enlarged; the pelvis was dislocated in the direction of the upper pole with partial obliteration of the middle and complete obliteration of the lower calices. The proximal portion of the ureter was displaced mesially. The entire left renal pelvis was filled with the calculus mentioned above. Roentgenograms of the chest revealed an area of opacity at the

midperiphery of the left lung field, suggesting a metastatic growth. No evidences of metastasis were found in the skull or long bones.

Death occurred forty-one days after hospital admission and autopsy showed a hypernephroma of the right kidney with widespread metastases, involving the opposite kidney, the lungs and tracheobronchial lymph nodes, the intestinal tract, and both suprarenals, as well as renal and biliary calculi and suprarenal hyperplasia.

The author considers the associated virilism the most interesting feature of the case, as this is most unusual with hypernephroma. He attributes it to the hyperplasia of the suprarenals and leaves open the question of a possible aggravating rôle of the metastatic invasion of these organs.

Another Case of Spontaneous Rupture of the Renal Pelvis. Axel Renander. Acta radiol. **22:** 422–424, May 1941. (In English.)

The author reports a second case of spontaneous rupture of the renal pelvis, supplementing his earlier report on this condition (Acta radiol. **21:** 343, 1940 Abst. in Radiology **36:** 755, 1941).

RADIOTHERAPY

MALIGNANT TUMORS

Concentration Method of Radiotherapy for Cancer of the Mouth, Pharynx, and Larynx. Max Cutler. J. A. M. A. **117:** 1607–1610, Nov. 8, 1941.

This study is based on 850 cases treated in the Chicago Tumor Institute and the Hines Veterans Hospital.

Cancers of the mouth, pharynx, and larynx fall into two broad general groups from the point of view of radiosensitivity and radiocurability. (1) The radiosensitive group includes those lesions originating in the mucous membrane overlying loose connective tissue, which lack the power to infiltrate the underlying muscle but grow for long periods as movable non-infiltrating lesions. Classic examples are cancers originating in the tonsil, epiglottis, false cords, pyriform fossa, and aryepiglottic fold. (2) The radioresistant group is made up of lesions arising in the mucous membrane overlying dense connective tissue and having a tendency to early infiltration of the underlying muscle with early fixation of the surrounding structures. An example of this type is infiltrating, adult, hornifying squamous carcinoma of the anterior two-thirds of the tongue. The 25 per cent of cures by external radiation have occurred in the radiosensitive group and the 75 per cent of failures in the radioresistant group.

Since 1938 the author has endeavored to extend the effectiveness of external radiation to the more radioresistant lesions. The basis of the concentration method is the use of large daily doses over a short treatment period (nine to twelve days) and a total dose sufficient to produce an "epithelite" and "epidermite." Treatment has been executed with telecurietherapy and with roentgen rays (200 and 400 kilovolts). Intensities varying from 3 roentgens per minute to 10 roentgens per minute have been used. The author warns against higher intensities with this new technic.

In view of the fact that the central portion of a carcinoma is more radioresistant and therefore requires more intensive irradiation than the periphery, a technic has been developed in which the size of the field is gradually reduced and the daily dose gradually increased. In the roentgen treatment of intrinsic cancer of the larynx, for example, the author generally begins with a field of 48 sq. cm. This is reduced gradually to a final field of 12 or even 6 sq. cm. Great care and precision are necessary with the use of the smaller fields. A centering device is used and the patient is carefully immobilized.

One highly important fact emerges from the author's experience, namely, that the more radioresistant the lesion the shorter must be the treatment time and the larger the daily dose. The more radioresistant lesions require not only an adequate total dose but an adequate daily dose. Total treatment periods varying between four days and eighteen days are being tested. The treatments are given twice daily and continuously. All lesions are treated on the assumption that they belong to the more radioresistant variety.

Telecurietherapy is done with a 10 gm. radium bomb which is used at 12.5 cm. distance, with ports varying from 10 cm. in diameter to 4 sq. cm.

One group of cases has been treated in two cycles (interrupted treatment) separated by an interval of eleven to fifteen days. This technic is especially useful in carcinoma of the pharynx and larynx. The effect on the lesions appears to be fully as pronounced as with continuous treatment and severe reactions are avoided. The principle of concentration is utilized here, also.

Since this new technic has been used only three and one-half years, the author can say nothing of the permanence of the results. It has been established, however, that certain carcinomas of the mouth, pharynx, and larynx which failed to respond to all other methods of external irradiation have shown decided regression and in many instances have disappeared completely under this new method of external irradiation.

CLARENCE E. WEAVER, M.D.

Cancer of the Tonsil. Hayes Martin and Everett L. Sugarbaker. Am. J. Surg. **52:** 158–196, April 1941.

In this special monograph the authors discuss in detail the etiology, clinical course, treatment, end-results, and prognosis of cancer of the tonsil, as observed in a series of 157 cases seen in Memorial Hospital (New York).

Though the accessibility of the tonsil would seem to suggest surgery as the procedure of choice in these cases, actually it has little to offer, since the primary lesions are seldom small or sufficiently localized in the tonsillar fossa to be operable when first seen. In only 2 of the series of 157 cases did the primary growth measure as little as 1 cm. in diameter and in both of these metastases were clinically demonstrable.

Radiation therapy, on the other hand, is particularly suitable in tonsillar cancer. The area is accessible to irradiation both through the skin of the neck and perorally; the tumor is among the more radiosensitive of pharyngeal and oral tumors, and the upper portion of the pharynx, in contrast to the hypopharynx, can be heavily irradiated without seriously impairing any vital function or bringing on grave complications. Furthermore, the most frequent site of metastasis is the subdigastric lymph node, which lies in the upper deep cervical region, only a little below the level of the tonsil itself, and can therefore be treated through the same portal as the primary lesion.

There is some diversity of opinion as to the technic to be employed and references are included to papers representative of various views. At the Memorial Hospital it has been found that the number of permanent cures is increased and the percentage of untoward sequelae reduced by using submaximal doses of fractionated roentgen radiation, supplemented in most instances by implantation of radon seeds.

External radiation is given through the cheeks and sides of the neck. The portals, which are preferably circular, measure about 7 cm. in diameter, centered approximately at the mandibular angles. If the primary lesion is unusually large or there are widespread cervical nodes, a larger portal, oval in shape, may be used. If the primary lesion is of average size and confined to the tonsil, and if the jaws can be separated widely enough to admit a cylinder at least 4 cm. in diameter, peroral treatment should also be given (see Radiology **28:** 527, 1937, for a description of the technic).

With portals averaging 7 to 8 cm. in diameter (other factors being 200–250 kv., 50–60 T.S.D., 0.5 to 1.0 mm. Cu filter), the daily dose should be about 350 r given to alternate sides until about 3,500 r × 2 has been administered. If peroral radiation is also employed, the single dose with a 4 cm. portal should be about 400 r given in rotation with the external cheek portals, the total dose through the latter being 2,500 r × 2 and through the former 2,800 r.

After the completion of such dosage by one or the other of the above-mentioned plans, it should be decided whether the depth of the reaction and the degree of regression of the tumor indicate continuing with the external radiation beyond this point or whether further treatment should be given by radon seeds implanted in the metastatic nodes and also in the primary lesion. By external radiation alone, using two skin portals 7 to 8 cm. in diameter and with the other factors as above mentioned, the total dose may be raised justifiably to 4,000 r or even 4,500 r × 2. If a peroral portal is used in addition, the total dose may be as high as 3,000 r or 3,400 r × 2 plus 3,500 r through the peroral portal.

A better plan than either one of these is the administration of external radiation until the tumor has been reduced to a quarter or a fifth of its original size, after which supplementary treatment is given with radon seeds. In the average case the strength of the individual seeds should be between 1.0 and 2.0 mc., and they should be geometrically distributed throughout the residual mass, spaced about 1 cm. apart.

No plan of therapy is adequate for tonsillar cancer that does not take into consideration the cervical lymph nodes. As pointed out above, the subdigastric node, which is most frequently involved, can be irradiated at the same time and by the same beam as the primary lesion. In most cases, however, it will be found that cervical metastases will not regress completely under average or even under large doses of external radiation, and supplementary seeds are indicated for the involved lymph nodes more often than for the primary lesion. The seeds may be inserted either through puncture wounds in the skin or after cervical exposure of the outer surface of the node. The dosage is somewhat empiric and depends both upon the size of the residual node and upon the amount of external radiation previously given. A tissue dose of 5 to 6 S.E.D. should be sufficient as a supplementary dose, but 8 to 10 S.E.D. should be used if seeds alone are employed without preliminary x-radiation. Neck dissection is seldom indicated.

The authors devote a number of pages to the complications of radiotherapy and their management. General toxic effects are best prevented by avoiding over-large portals. An acute blistering or epidermicidal skin reaction and a severe mucosal reaction are usually unavoidable but can be controlled by appropriate measures. Dysphagia is always present to some extent when an acute reaction is produced in the pharynx, and a feeding tube inserted through the nasal cavity may be necessary at the height of the reaction to insure adequate nutrition.

Radionecrosis calls for special attention to oral hygiene. It may be present in small volume in the upper pharynx and oral cavity without jeopardizing the end-result. One of its most serious consequences is hemorrhage. Osteomyelitis of the underlying mandible may also occur.

Local recurrence may take place within a month or even a year or more after treatment. In such cases the prognosis is poor. None of the 24 patients with recurrent growths in the authors' series survived for five years.

End-results were available in 148 of the series here recorded: 122 patients were dead or alive with recurrence; 26 were free from disease after five years or longer.

Breast Cancer: A Study of the Train of Events Which May Follow Radical Removal and Post-Operative X-Ray Therapy. Ff. Roberts. Brit. J. Radiol. **14:** 269–274, August 1941.

One hundred forty-three patients with breast cancer were studied with the idea of determining if our methods of treatment can be improved upon. All these patients were treated by radical mastectomy and post-operative x-ray therapy. Recurrences were observed in 61.

The commonest sites of recurrence were the breast region, neck of the affected side, and bones, in the order given. There were no instances of recurrence in the axilla. The prognosis was found to be better in recurrences in the breast region and neck than for metastases in bone. The first recurrence appeared, on an average, two years following operation. In the majority of instances, a single recurrence remained isolated for some time.

The location of the recurrences suggests that it would be advisable to irradiate the breast region and the adjacent neck area more intensively and omit irradiation of the axilla. It would seem that it might be advisable to give a prophylactic treatment to the spine.

SYDNEY J. HAWLEY, M.D.

Radiation Therapy in Carcinoma of the Lung. William V. Tenzel. J. A. M. A. **117:** 1778–1782, Nov. 22, 1941.

Radiation therapy for primary carcinoma of the lung has not been effective as a curative agent. Its usefulness in palliation, however, and in prolonging life, should not be overlooked, though even in these spheres its value has been challenged. The author's report is based on an analysis of 192 treated and untreated primary carcinomas of the lung; 50 cases were classified as adenocarcinomas, 105 as epidermoid carcinomas, and 37 as anaplastic carcinomas. There were 121 untreated and 68 irradiated patients. An average period of five and one-half months elapsed between the onset of symptoms and the diagnosis.

For the irradiated patients the average duration of life from onset of symptoms to death was fifteen months; for those not given irradiation it was only ten months. The survival period was longest in epidermoid carcinoma and shortest in adenocarcinoma. Of the irradiated group, 50 per cent were alive at the end of one year, while 21 per cent of those not given radiation therapy survived this period.

The technic of irradiation depended on the extent of the lesion and the condition of the patient. An arbitrary point was chosen, located 10 cm. from the anterior, posterior, and lateral walls of the chest. In most cases such a point lies somewhere within the tumor. The dose delivered to this region was called the tumor dose. As the tumor dose increases there is a definite and progressive increase in the survival period. With 1,000 to 2,000 r the survival period was eleven and one-half months; with 2,000 to 3,000 r, twelve months; with 3,000 to 4,000 r, thirteen months; with 4,000 to 5,000 r, fourteen months; and with 5,000 to 6,000 r, twenty-two months.

In only a relatively small number of patients did the disease remain local. At autopsy 92 per cent of the adenocarcinomas and anaplastic carcinomas showed distant metastases. There is little chance for successful therapy in these two groups. The possibilities appear to be greater in the epidermoid group, as one-third of these patients had no distant metastases at autopsy. Unfortunately, however, epidermoid carcinoma is frequently associated with local infection. It occludes the bronchus early, with resultant atelectasis, and often goes on to abscess formation. This is not so apt to occur with the other types.

Since the general health of patients with carcinoma of the lung is poor, they are often unable to withstand a course of vigorous radiotherapy. The symptoms most frequently relieved were cough, expectoration, hemoptysis, and pain in the chest. Symptomatic relief was obtained by 45 per cent of the patients treated.

CLARENCE E. WEAVER, M.D.

Transitional Cell Carcinoma of the Upper Respiratory Tract. I. Frank, M. Lev, and M. Blahd. Ann. Otol., Rhin. & Laryng. **50:** 393–420, June 1941.

A study of malignant tumors of the upper respiratory tract was made by the authors in an attempt to clarify the nature of these lesions because of the confusion as to their nomenclature and biologic character.

The relative merits of various terminology of these tumors are discussed. Upon the basis of morphology malignant tumors of epithelial origin are classified as squamous-cell carcinoma, transitional-cell carcinoma, squamous-cell carcinoma with transitional-cell features and *vice versa*, and atypical carcinoma. There appeared to be no difference between transitional-cell and squamous-cell carcinoma in so far as regional and distant metastases are concerned. Atypical carcinoma showed a greater tendency toward regional metastasis than the other types. With radiation therapy the prognosis was better for patients with transitional-cell and atypical carcinoma than for those with squamous-cell lesions.

The number of mitotic figures in the transitional-cell carcinomas seemed to be a more important criterion for the evaluation of the degree of malignancy than cellular atypism.

L. W. PAUL, M.D.

Classification of Gastric Carcinoma. Rudolf Schindler, Paul E. Steiner, William M. Smith, and Morris E. Dailey. Surg., Gynec. & Obst. **73:** 30–39, July 1941.

Because of the lack of any classification of gastric carcinoma having a definite bearing on prognosis and treatment, the authors undertook the study described here. A preliminary histologic grading of about 200 examples, based on the degree of deviation from normal gastric gland structure, failed to show any definite correlation with the clinical course or surgical curability of the disease. Borrmann's macroscopic classification (see Henke-Lubarsch: Handbuch. d. spez. Path., Berlin, Julius Springer, vol. 4, pt. 1, p. 865), on the other hand, proved a more satisfactory guide. His four gross types are, briefly:

I. Polypoid carcinoma (2.9 per cent of all cases)
II. Non-infiltrating carcinomatous ulcer (17.6 per cent of all cases)
III. Infiltrative carcinomatous ulcer (16.3 per cent of all cases)
IV. Diffuse infiltrating type (63.2 per cent of all cases)

In a comparison of the histologic grades and these gross types in a series of 50 cases it was found that of 3 tumors of Borrmann's Type I, one was histologically grade 2, one grade 3, and one grade 4; 9 of 15 Type II, 5 of 9 Type III, and 21 of 23 Type IV tumors were histologically of grade 4.

Three cases are recorded representing gross Types I, II, and IV. Histologically the Type I growth was of grade 3, but the patient was well seven years after operation. A good result was also obtained in Type II (histologically grade 2). The patient with the Type IV tumor, though this was of minimal size, died of recurrence two years after operation.

The authors record it as their preliminary impression that the gross Types I and II often give excellent end-results after surgical interference, while the infiltrating Types III and IV are unfavorable, but state that this requires confirmation by extensive research. They believe also that an attempt should be made to establish new histological criteria and site Haagensen's study of breast tumors (Am. J. Cancer **19:** 285, 1933) as a model in this respect.

Primary Sarcoma of the Stomach. A. L. Cameron and P. J. Breslich. Surgery **9:** 916–930, June 1941.

The authors report 2 cases of gastric sarcoma and review 104 cases from the literature.

The first of their 2 patients was a male, aged 48, seen because of an attack of severe abdominal pain of twenty-four hours' duration, followed by abdominal distention, nausea, vomiting, chills, and fever. At irregular times during the past fifteen years he had suffered attacks of severe pain just to the left of the umbilicus, which had lasted a few hours and were relieved by a bowel movement. Four weeks before admission, the pain had appeared in the same location and continued ever since, being sharp for short intervals only and relieved by bowel movement. On admission the patient was very sick, with symptoms of bowel obstruction.

At exploratory operation, a large, immobile, nodular upper abdominal mass was felt, attached to the transverse colon. The intestines were distended. The abdomen was closed and the patient died on the fifth postoperative day.

At autopsy a tumor was found in the stomach, both intra- and extra-luminal. There was a crater-like ulcer of the gastric mucosa 2.5 cm. in diameter. Metastases were present in the liver and retroperitoneal lymph nodes and there was infiltration of the submucosa and muscularis of the stomach. Microscopically, the tissue was that of a spindle-cell sarcoma.

The second patient was a male, aged 62, with symptoms of five weeks' duration: loss of appetite, weakness, and loss of weight. Onset was with a severe colic to the left of the umbilicus. A large tumor was palpable and a large defect was demonstrable roentgenographically on the greater curvature of the stomach. There was no gastric retention.

At operation, a large nodular tumor was observed, attached firmly to all surrounding viscera including the spleen. The mass was resected and removed. The patient was seen several times and a second operation was done sixteen months later. Two months after this he died. The microscopic report was leiomyosarcoma. There were no metastases.

There are many different classifications and terminologies used to describe sarcomas of the stomach. Practically, the authors divide the cases into two groups: spindle-cell sarcoma and malignant tumors of lymphoid origin. Sex incidence is not noteworthy. Three-fourths of the reported cases were observed in the fifth, sixth, and seventh decades.

The spindle-cell sarcomas are the large and bulky growths which protrude outward to a marked degree in about one-half the cases and less often project within the gastric lumen. They are often extremely large, and are frequently pedunculated. Growth is by expansion and seldom by infiltration or invasion. Any part of the stomach may be the site of origin. The proximal divisions seem to be most frequently involved. There is rarely any obstruction of the orifices. Involve-

ment of the mucosa and serosa is always secondary. Single or multiple ulcers are usually present as a late complication, bleeding freely. Extensive degenerative changes occur frequently. Metastases are relatively infrequent and occur most often in the liver.

Radiation therapy has no place in the treatment of spindle-cell sarcoma. Surgical resection or excision is the only corrective procedure practised, with an inoperability rate of 74 per cent. Only 5 patients are reported to be living and well for one year or more after operation.

The largest division of sarcomas of the stomach in this collection is made up of malignant tumors of lymphoid tissue. In this series males predominate 2 to 1; the average age is 42 years. These tumors occur most frequently as single, flattened, diffuse infiltrative masses, occurring most frequently on the lesser curvature and in the distal third. Saddle formations at the curvatures with extension to both walls are the rule. One-fourth of the cases were annular, producing stenosis of the pylorus. Occasionally the tumor attains a large size due to uniform thickening of a large portion of the stomach and less often to a massive projection from a limited area. Ulceration occurs frequently and is superficial, but extensive. Metastasis was twice as frequent as in the spindle-cell sarcomas. Two-thirds of these tumors were operable. The operative mortality is 22 per cent.

These tumors are more radiosensitive than the spindle-cell group, but results are still disappointing. Only two patients were treated by irradiation alone, one of whom was living, but not well, six and a half years after treatment. Perforation following radiation is reported to have occurred twice in the same patient.

JOHN E. WHITELEATHER, M.D.

Primary Cancer in the Uterus and in the Rectum of the Same Patient: A Study of Twelve Case Histories. Eric Nordlander. Acta radiol. **22:** 439–460, September 1941.

During the twenty-five-year period from 1914 to 1938, the Gynecology Department of the Radiumhemmet in Stockholm treated 4,410 patients with uterine cancer. In only 73 (1.7 per cent) of these cases was a primary cancer observed in other organs. The combination of cancer of the uterus with non-metastatic cancer of the rectum was seen in 10 cases (omitting 2 cases in which microscopic examination of the rectal tumor was lacking). The most frequent combination with cancer of the uterus was cancer of the breast. This combination occurred in 29 cases (0.7 per cent). Considering the frequency of malignant tumors in general, the explicit statistics of the author serve to underscore the relative rarity of primary tumor multiplicity. The differential diagnosis from possible metastasis is furnished by clinical observations and detailed microscopic studies.

Nordlander believes that the comparatively higher percentage of primary cancers of the uterus and the rectum may be due to the fact that the patients were subjected to a repeated control, including both rectal and vaginal examination. On the other hand, he does not think that radiation therapy of the primarily observed uterine cancer played any significant part in the development of the later rectal tumor. Detailed histories and clinico-pathological findings with a critical discussion of the salient features allow the reader not only to follow the author in his reasoning but also to reach his own conclusions in this interesting—and so far largely neglected—question of multiple primary tumors.

E. A. SCHMIDT, M.D.

Cancer of the Bladder. Ralston Paterson. Brit. J. Radiol. **14:** 219–233, July 1941.

Cancer of the bladder may be classified clinically into three groups, benign papilloma, non-infiltrating cancer, and infiltrating cancer. While benign papilloma is not strictly speaking a cancer, its strong tendency to recur justifies its inclusion with these malignant growths.

Non-infiltrating cancer includes an extensive series of growths which are macroscopically of a papillary character. Their essential feature is their superficial character. They involve only the epithelial lining of the bladder and do not infiltrate the wall proper. Infiltrating cancer may be heaped up in places and may superficially resemble a non-infiltrating cancer, but careful examination will reveal the absence of a pedicle and evidence of involvement of the bladder wall. There is some overlapping of types. The lesions are mostly of low-grade malignancy, but should be treated vigorously in spite of this.

Hematuria is the predominant symptom in all types. The non-infiltrating type usually produces painless bleeding, while in the infiltrating type bleeding is associated with pain. Cystoscopic examination is the most important diagnostic measure. Considerable information may be gained, also, from radiographic examination. The author advises a double contrast method, instilling first 3 c.c. of barium and acacia mixture. The patient is rolled about to spread the barium, and 50 to 80 c.c. of air are then injected. Roentgenograms should be made laterally as well as anteroposteriorly, and occasionally oblique views may be needed.

Although surgical treatment is generally regarded as the better, the author feels that adequate radiation therapy will give equally good results. If the lesion is reasonably early and the prognosis favorable, irradiation should be planned to accomplish cure with the first course. If not, palliation only should be attempted.

Cases suitable for radium therapy are non-infiltrating cancers up to 4 cm. in diameter, infiltrating cancers with ulcers no more than 2 cm. in diameter, single lesions of non-infiltrating type with small pedicles, and multiple lesions, not exceeding three in number, none of which is extensive. For curative x-ray therapy the patient must be in good general condition. In this group fall multiple non-infiltrating lesions, even of large number; single non-infiltrating lesions over 4 cm. in diameter; infiltrating lesions over 2 cm. in diameter, provided they are still limited to the bladder. Palliative treatment is indicated in patients in poor general condition and those with lesions extending beyond the bladder.

Radium implantation through the cystoscope is not advised, as it is too difficult to do accurately. Gold seeds implanted through a suprapubic wound are better. The dosage should be between 6,000 and 7,000 r.

For curative x-ray treatment a 6,000 r tumor dose should be planned in five weeks. The author advises giving this through numerous small ports by the mechanical beam direction method of Dobbie, as other methods are too inaccurate in localization. For palliative therapy a 2,000 to 2,500 r tumor dose may be given in four days through fewer larger ports.

These methods have not been used long enough to allow five-year figures to be given, but the primary results in comparable cases are equally as good as those with surgery.

In selected cases the use of contact therapy through a suprapubic wound is advisable. This method is recommended in the treatment of benign papillomata.

SYDNEY J. HAWLEY, M.D.

Benign and Malignant Giant-Cell Tumors of Bone: Diagnosis and Result of Treatment. Henry W. Meyerding. J. A. M. A. **117:** 1849–1854, Nov. 29, 1941.

Confusion has existed in the classification and study of so-called giant-cell tumors of bone. The author suggests the use of the terms "benign giant-cell tumor" and "malignant giant-cell sarcoma," in an attempt to clarify the differentiation. In some cases in which the

lesion has been of long standing, a malignant change may occur and regions of typical benign giant cells, composing most of the tumor, may contain smaller foci of malignant cells. The malignancy in such instances is apparently of low grade. This type of tumor is radiosensitive. Pathologists have found similar microscopic tissue present in cases of osteitis fibrosa cystica. Roentgenograms demonstrate the size, rapidity of growth, location, osteoclastic character, penetration or invasion of soft tissue, and the earliest evidence of pulmonary metastasis.

Of 124 patients with giant-cell tumor seen during the quarter of a century from 1916 to 1940, the lesions were benign in 101; in 23, or 19 per cent, they were malignant. It is the author's practice to have these tumors examined by means of frozen section at the time of operation and rechecked in permanent sections later. The added advantage of a microscopic diagnosis far offsets any danger which may be ascribed to biopsy.

In treatment the aim is to establish a diagnosis, determine the benignancy or malignancy of the tumor, and to adopt that method of treatment which has proved most satisfactory. In those cases considered inoperable irradiation is carried out.

Irradiation has won a distinct place in the treatment of these tumors; 23, or 19 per cent, of the author's patients were so treated, and some excellent results were obtained in apparently rather hopeless cases. While in the majority of instances surgical treatment offers the most rapid and certain cure, the author believes that irradiation, alone or in combination with surgical treatment, will prove of increasing value in selected cases of benign giant-cell tumor and of malignant giant-cell sarcoma.

Excision followed by irradiation has gained in popularity. In cases in which there is a low degree of malignancy this method should show improved prognoses. In the author's benign group, 16 patients were operated on five years or more before this study was made, all of whom were traced and were living when the study was made, thus giving a five-year survival rate of 100 per cent. In the group in which the lesion was malignant, there were 5 patients on whom the procedure was performed five years or more before the study was made. All of them were traced and 3, or 60 per cent, had lived five years or more.

An increasingly valuable method of treatment and one that requires special technical knowledge is the complete excision of the tumor followed by immediate filling of the defect with bone grafts. In a group of 6 cases irradiation was given after excision and bone grafting. In 5 of these operation was performed more than five years before this study was made. Three patients were traced and all of them had lived five years. None of these had malignant lesions. Excision and bone grafting with or without irradiation result in the saving of extremities in cases which in former decades were considered hopeless, with amputation as the only method of choice.

Resection of the entire portion of the bone containing the tumor has a very limited field, but in certain cases such as involvement of ribs, radius, ulna, and fibula it is a method of choice. Amputation was performed in 27, or 21.8 per cent of the author's cases. Thirteen, or 65 per cent, of 20 patients who had malignant lesions lived five years.

Case reports illustrating different types of lesions with treatment and results are given.

CLARENCE E. WEAVER, M.D.

Hodgkin's Disease: Review of Fifty-four Cases. R. E. Burger and E. P. Lehman. Arch. Surg. **43:** 839–849, November 1941.

This discussion is based on 54 cases of histologically proved Hodgkin's disease. All races and nationalities may be involved, and the condition is more prevalent in men. The age distribution in the series here recorded was from four to seventy years. No predisposing factor could be observed; in 13 per cent of the cases there was a healed or active tuberculosis.

The chief symptoms were swelling of the cervical lymph nodes, weakness, fatigue, weight loss, cough, dyspnea, and backache. The average duration of symptoms before entry was ten and a half months. Localization is throughout the lymphatic system, but at the onset the involvement is commonly unilateral. Involvement of the stomach, liver, skin, and bones is fairly common. The blood picture is rather variable, but there is usually a progressive hypochromic anemia; leukocytosis occurred in half the patients. Eosinophilia was noted in only 20 per cent. Fever was observed in 90 per cent, but it was more often a swinging fever of 100 to 104° F. than a Pel-Ebstein type.

The average duration of life for the 41 patients now dead was twenty-six months, with extremes of three months and eight years eight months. In the 9 patients known to be living the average duration to date is twenty-nine months; only 3 have lived longer than five years. In 28 cases in which a known secondary cause of death could be tabulated, terminal exhaustion, anemia, and pyrexia were most frequent. Treatment was by roentgen therapy, radium therapy, or surgery; 5 patients were not treated. In the treated cases the average survival period was about twenty-eight to thirty months for all three types of treatment; in the 5 untreated cases the average was ten months. Spray radiation technics were not used in this series.

LEWIS G. JACOBS, M.D.

Radiosensitivity of the Bone Marrow. Torfinn Denstad. Acta radiol. **22:** 347–359, May 1941. (In German.)

The author summarizes his observations on the radiosensitivity of the bone marrow as follows: The erythropoietic as well as the myelopoietic cells of bone marrow are very sensitive to the action of rays, especially the first mentioned ones. The immature forms are the first to disappear. The regeneration capacity, however, is good, even if large doses are administered. It is assumed that granulocytopenia, and most likely also lymphopenia, following radiotherapy are both due to a long-distance action of the rays, an inhibiting action on myelopoiesis and lymphopoiesis. The conclusions which might be drawn from this supposition with regard to the action of radiotherapy on leukemia and polycytosis are discussed.

Symptoms and Signs of Metastatic Cancer. Richard B. Phillips. Am. J. Surg. **53:** 486–489, September 1941.

The author emphasizes the importance of bearing in mind the possibility of metastatic cancer in studying roentgenograms of whatever organ or bone. X-ray studies of the chest, in particular, should be done much more frequently than at present and upon far less indication. It is true that the prognosis is generally unfavorable in cancers which are first revealed through symptoms due to metastases but, on the other hand, much useless and even harmful treatment can be avoided by a correct diagnosis and palliative measures can frequently be instituted. Ten cases are reported.

Regional Lymphatic Metastases of Carcinoma of the Stomach. F. A. Coller, E. B. Kay, and R. S. McIntyre. Arch. Surg. **43:** 748–761, November 1941.

This study is based on dissection of the regional lymph nodes in 53 cases of carcinoma of the stomach; 51 were specimens secured at operation and 2 were specimens secured at autopsy. In 40 cases metastatic deposits were found. As some of the operative specimens were not very large, more metastases would probably have been discovered if examination had included larger segments.

Carcinoma may spread through any one of three lymph drainage systems of the stomach; that is, the intramural, the intermediary, or the extramural. This last may be divided into four zones, the inferior gastric, the pancreaticolienal, the superior gastric, and the suprapyloric. All four are commonly involved, but the first and third seem most important and are often inadequately excised. The first zone was involved 34 times in the 40 cases with metastases; the second was involved 7 times; the third was involved 23 times, and the fourth was involved 12 times. In 5 cases all four were involved; in 4, three zones; in 15, two zones, and in 16, one zone.

Location of the neoplasm was not a great factor in determining the zone involved in spread; annular carcinoma was apt to involve all four zones. Sex seemed to have little influence on the occurrence of metastases; patients with metastases tended to be somewhat younger than those without. Duration of symptoms was 12.87 months in those with metastases, and 13.45 months in those without. There was no relation between the size of the growth and the presence of metastases. Sessile lesions tended to be more malignant. The deeper the infiltration, the greater the chance of metastasis. There was a marked direct relation, also, between the grade and the occurrence of metastasis. Medullary and scirrhous carcinomas had the highest percentage of metastases; all of these lesions were of grade 3 or 4.

The author concludes, among other things, that the inclusion of all four zones of lymphatic spread in resection will increase the chance of cure.

L. G. JACOBS, M.D.

Distant Metastasis in Cancer of the Upper Respiratory and Alimentary Tracts. Ralph R. Braund and Hayes E. Martin. Surg., Gynec. & Obst. **73:** 63–71, July 1941.

This study of cancer of the upper respiratory and alimentary tracts is based on an autopsy series of 284 cases in which the primary tumor was determined histologically. In 278 cases the original growth was a squamous carcinoma; in 6, an adenocarcinoma. One hundred and nineteen patients had cervical lymph node metastases on admission.

Distant metastases were present in 66, or 23.2 per cent of this series of cases, the most usual sites being the lungs, liver, and pleura, in the order given. Cancers of the mucosa of the cheek showed the highest incidence of distant metastases, 40 per cent of 10 patients. The figures for the other sites were as follows: esophagus, 37.5 per cent of 56 cases; gum, 36 per cent of 14 cases; nasal cavity and sinuses, 35.7 per cent of 14 cases; palate, 27 per cent of 11 cases; wall of pharynx, 25 per cent of 8 cases; extrinsic larynx, 18.4 per cent of 38 cases; tongue, 18.3 per cent of 60 cases; lip, 15.4 per cent of 13 cases; intrinsic larynx, 11.8 per cent of 17 cases; tonsil, 11 per cent of 27 cases; floor of mouth, 6.2 per cent of 16 cases.

The incidence of distant metastases at autopsy in patients with cervical lymph node involvement on admission was two and one-half times that for patients in whom the local lesion was the only evidence of disease at the first examination. No patient with epidermoid carcinoma of the mouth, nasal cavity, pharynx, or larynx had blood-borne metastases in distant tissues who did not, at some time during the clinical course of his disease, have cervical lymph node involvement. The morphology of the tumor seemed to have no bearing on the probability of metastasis.

Reliability of Certificates of Death from Cancer. Harold F. Dorn and Joseph I. Horn. Am. J. Hygiene. **34:** Sec. A, 12–37, July 1941.

A U. S. Public Health survey of ten urban areas, in a study of the incidence of cancer in 1938–1940, disclosed a rather high degree of discrepancy between the physicians' diagnoses and diagnoses entered on death certificates. In many known cancer cases death was attributed to non-malignant conditions and in many others the primary site was not designated. Of 90 cases of brain neoplasm, 48 per cent entered the census statistics as non-malignant; 10 per cent of epitheliomas; 5.7 per cent carcinoma of the respiratory tract and 4.5 per cent genito-urinary neoplasms were similarly classified.

A total of 13,524 cases were carefully studied and comparisons were made between survey case history findings and final death certificate reports. It was found that 645 were reported non-malignant, 408 were placed in a heterogeneous group labelled "all other malignancy." Less than 75 per cent agreement was found in cancers of lip, jaw, pharynx, lungs, and pleura. Where a physician's report reads bronchogenic cancer, the coding rules place such a diagnosis in the "other and unspecified" category. Consequently, the published number of deaths from cancer of the lung is too small. In Atlanta, Ga., 30.6 per cent disagreement was found, with a 7.8 per cent non-malignant death certificate report in known cancer cases. It is shown that even where the diagnosis is confirmed by biopsy, essentially the same degree of discrepancy exists. Surprising examples of error in death certificate diagnoses are illustrated in 1,925 cases of carcinoma of the stomach as entered on certificates. Actually 4 cases were primary in the prostate, 3 in the urinary bladder, 6 were hypernephromas, 13 originated in the uterus, 5 in the lungs and pleura, 11 in the pancreas, 34 in the liver, 20 in the esophagus, and 53 in the intestines. (One is, of course, dubious of an incidence of 34 hepatomas, as this is a relatively rare tumor.)

Only 75 per cent agreement was found in age designations. In this respect the doctor was found to be in error more often than the death certificate.

In summarizing, the authors conclude that the greatest fault lies in unspecific entries on death certificates, which lead to the coding of the cause of death as "non-malignant" or "all other malignancy."

MAX MASS, M.D.

NON-MALIGNANT CONDITIONS

Results of Roentgen Treatment of Spondylosis Rhizomelica (Spondylarthritis Ankylopoietica). H. J. N. Dekkers and J. van Ebbenhorst Tengbergen. Acta radiol. **22:** 522–534, September 1941. (In English.)

According to van Ebbenhorst Tengbergen and Dekkers, the duration of the disease is of paramount importance in the x-ray treatment of rhizomelic spondylosis. They divide their clinical material of 27 cases as follows:

Group 1: complaints existing less than one year
Group 2: complaints from 1 to 3 years
Group 3: complaints from 3 to 5 years
Group 4: complaints over 5 years

The majority of the cases were far-advanced, with extensive involvement of the spine, the intervertebral joints, and the sacro-iliac junctions. The patients varied in age from 19 to 50 years. Many of the cases had been treated as sciatica or lumbago. The preroentgen treatment, as a rule, had consisted in different forms of physical therapy or in the injection of Warren-Crowe vaccine. The x-ray treatments were usually given over 4 fields of the vertebral column, the first field including the medulla oblongata and the fourth the sacro-iliac junctions. Generally, 200 r were applied per treatment (180 kv. and 0.8 Cu filter) to as many fields as necessary, at two-day intervals. This quantity was given three times, with fourteen days between courses. After six weeks, a second series was applied, and in some cases a third series was given. Occasionally a separate treatment course was ad-

ministered over the hip joints. The total dose ranged between 1,200 r and 2,800 r in most cases, but some patients received only between 200 and 1,000 r.

The effects of the treatments varied in an inverse ratio to the duration of the disease. While good in the early stages they were less satisfactory in cases of longer standing. Of the 27 patients treated, 18 showed some improvement; 15 were even able to continue their daily work. In 18 cases the blood sedimentation rate decreased, but in only 4 cases did the function of the spine improve materially.

The authors conclude their article by saying that "this form of therapy is an improvement in this serious disease . . . but does not justify in giving way to excessive optimism." E. A. SCHMIDT, M.D.

Present Status of Roentgen Therapy in Sinusitis. K. Kornblum. Ann. Otol., Rhin. & Laryng. **50:** 523–543, June 1941.

The author reviews the literature dealing with the treatment of sinusitis by means of roentgen rays. In spite of considerable variation in the technics employed by the various investigators, the results have been quite uniform. As long as certain general principles are observed, the precise method of administration seems to be of no great importance. Because of the sensitivity of the tissues treated, only small amounts of radiation are required to be effective. It is stressed that close teamwork between the rhinologist and the roentgenologist is an absolute essential for best results. The proper selection of cases is important and can be done only by the rhinologist. Acute sinusitis may be treated successfully if small doses (maximum of 50 r) are used and the patients closely observed. Subacute sinusitis can be treated with moderate doses, and this group accounts for the largest percentage of good results. In chronic hyperplastic sinusitis the results of treatment are fairly satisfactory, but in those forms associated with extensive fibrosis little is to be expected from roentgen therapy. Sinusitis in children offers an excellent field for radiation therapy in the opinion of the author and forms the most important group for this type of treatment. L. W. PAUL, M.D.

DOSAGE

A Survey of Depth Dose Data. W. V. Mayneord and L. F. Lamerton. Brit. J. Radiol. **14:** 255–264, August 1941.

Depth dose data reported by various investigators have been correlated in an effort to arrive at a more standard set of figures. The results are presented in tables covering the variation of percentage depth dose with focal-skin distance, quality, and size of field. Radiation of 1.0 mm. to 5.0 mm. Cu half-value layer, field areas up to 400 sq. cm., and focal-skin distances from 40 to 100 cm. are thoroughly covered. A less comprehensive survey of radiations up to 17 mm. Cu half-value layer is included. Mean values of back-scatter at the surface for areas up to 400 sq. cm. and half-value layers up to 14 mm. Cu also are given.

SYDNEY J. HAWLEY, M.D.

RADIATION INJURIES

Surgical Management of Postradiation Scars and Ulcers. Herbert Conway. Surgery **10:** 64–84, July 1941.

Surgical management of the lesions caused by the tissue-destructive rays of both roentgen and radium radiation presents problems which call for a knowledge of and the application of practically all of the principles of plastic surgery.

Post-irradiation injury is an unfortunate after-effect but may be condoned if produced in the treatment of inoperable cancer. In the treatment of benign or malignant lesions within the scope of surgery, however, it is difficult to acknowledge a method of therapy which carries with it the danger of so serious a complication.

A number of widely different methods of treatment have been acclaimed in the dermatological treatment of postradiation scars and ulcers. Treatment with ultraviolet light, Finsen-Reyn lamp, electrodesiccation, radium, scarification, trichloracetic acid cauterization, Dodd's solution (containing phenol), and the fresh leaves of Aloe vera have been recommended, the last method being endorsed for ulcers but not for telangiectases, scars, keratoses, or atrophy. It is probable that electrodesiccation, actinic rays, and radium may accelerate destruction of tissue rather than retard it [see, however, Uhlmann: Radiology **38:** 445, 1942].

The methods available in the surgical management of post-radiation scars may be listed as follows: simple excision; excision and primary suture by means of sliding flaps; gradual partial excision; excision and replacement by thick split graft, whole thickness graft, or pedunculated flap.

In the management of the indolent ulcers resulting from radiation therapy, the following methods may be utilized: simple excision; excision and primary suture by means of sliding flaps; excision and replacement by multiple small deep grafts (after a period of antisepsis to allow granulation tissue to form), by thick split grafts, or by pedunculated flaps; amputation; section of regional nerves; periarterial sympathectomy.

The type of pedunculated flap to be used depends on the surface location of the lesion. Thus, gauntlet flaps have been used for fingers, double-pedicled flaps in the region of the anus, tubed pedicles for lesions of the torso, face, neck, and extremity. Amputation is seldom indicated except in those ulcers of the fingers in which the pain is unbearable, or which have become malignant. Periarterial sympathectomy has been advocated for relief of pain and for its benefit in bringing about healing of the ulcer, by Leriche and Fontaine.

Ten illustrative cases are reported. These are briefly as follows:

Case 1: Post-irradiation scars and telangiectases following roentgen therapy to the thyroid. Treatment was by sliding flaps.

Case 2: Scar on the left malar region in a girl of seventeen, left from treatment of an angioma during infancy. This was treated by gradual excision and immobilization of the facial muscles during the healing stage.

Case 3: Large scar on the right cheek following treatment with x-ray and radium for a hairy mole during infancy. This was treated by excision and a whole-thickness graft.

Case 4: This case was unusual in that the x-ray treatment had been given eighteen years before ulceration of the abdominal skin occurred. This was treated by wide excision, the wound being closed by mattress sutures without drainage.

Case 5: Ulcer of the anterior chest wall following intensive irradiation for metastatic melano-epithelioma. The lesion was both supra- and infra-clavicular. The patient died before surgical treatment of the ulceration could be instituted.

Case 6: Indurated ulcer of the right anterior abdominal wall following treatment of carcinoma of cervix. It was present three years after the treatment. A deep incision was made and all ulcerated tissue was removed. The wound was then closed by suturing the edges together.

Case 7: Malignant change in an ulcer following extensive x-ray treatment of chronic psoriasis of the legs. This was treated by excision and strip grafts.

Case 8: Ulcer of the lower abdominal wall following treatment for adenocarcinoma of the right ovary. The intestines were adherent to the inner side of the

abdominal wall. Extensive excision of the fibrotic fascia and peritoneum was necessary, with replacement by a rectangular free graft of fascia lata. After much antiseptic treatment and preparation a tubed skin flap was induced to take, closing the external excision.

Case 9: Malignant ulcer of the index finger in a physician. The finger was amputated at the metacarpophalangeal joint.

Case 10: Cancer of the skin of the face following x-ray treatment for acne. This had been treated by electrolysis previous to plastic surgery. Treatment was excision with whole-thickness graft.

JOHN E. WHITELEATHER, M.D.

Surgical Treatment of Post-Irradiation Necrosis. Ernest M. Daland. Am. J. Roentgenol. **46:** 287–301, September 1941.

Necrosis of normal tissues may follow the heavy irradiation necessary to eradicate malignant tumors. It is seen also as the result of carelessness or ignorance. Irradiation over an area previously operated on may produce necrosis because of the impaired blood supply. Ligation of a large vessel supplying an irradiated area may result in lethal damage to the entire area. Sepsis entering the irradiated area may cause a slough. Probably the commonest cause of necrosis, however, is the injudicious use of roentgen radiation over a section of skin already damaged by previous therapy.

Death of tissue may follow quickly after treatment or may be delayed a year or two. It is accompanied by severe pain. Surgical treatment consists in the radical removal of all the necrotic tissue with a wide enough margin to insure an adequate circulation. The author discusses under separate headings necrosis of cartilage, necrosis of the skull, of the jaw, of the lumbosacral region, and of the foot, with illustrative case records. With modern technic necrosis of cartilage is less often encountered than formerly. Irradiation osteitis of the skull is more serious than simple osteitis because the former involves all the tables, whereas the latter is usually limited to the outer table. In the buccal cavity oral sepsis is a contributing factor. Here, as elsewhere, any tissue which has undergone extensive irradiation shows extreme fibrosis and endarteritis. Late sloughs are due to insufficient blood supply. Extraction of teeth in a sloughing cancer spreads infection and therefore no dental work should be done on teeth which have been irradiated until at least two years have elapsed. The lumbosacral region appears to be particularly susceptible to irradiation necrosis; healing is slow and surgical measures are difficult. In plantar warts severe necrosis may follow prolonged or repeated irradiation. The necrosis produces severe pain and prevents weight-bearing or walking. Patients have been observed who, with but one series of treatments, have shown atrophy of the skin not noted with a similar amount of treatment to the face. The surgical treatment of these ulcers is difficult.

In all these ulcers pedicle grafts are more satisfactory than skin grafts.

Many excellent illustrations are presented.

S. M. ATKINS, M.D.

X-Ray or Radium Burn. Theunis Fichardt. South African M. J. **15:** 403–405, October 1941.

Fichardt calls attention to the necessity of understanding the mechanism of the production of radiodermatitis in interpreting the reaction. "Any medical man," he points out, "not acquainted with x-ray and radium reactions, examining such an ulcer and noting the time it is taking to heal, immediately says 'radium burn.' It is extraordinary with what relish and triumph the diagnosis of 'radium burn' is made and communicated to the patient."

In the application of radiant energy of this type to the skin or mucous membrane, certain reactions are produced. The destruction of cells calls forth the usual inflammatory mechanism of retardation of the blood stream and active migration of the leukocytes through the walls of the distended capillaries into the interstices of the surrounding tissues. Synchronous with the escape of the leukocytes is the exudation of the lymph which produces the inflammatory edema. More treatment produces desquamation, and the inflammatory products become glued together to form a yellow membrane. These ulcers can be healed only by cells which grow in from the sides.

The attitude of medical men toward what is recognized by radiologists as an excellent reaction has resulted in a tendency on the part of the latter to undertreat lesions. The radiologist is also often blamed for reactions in reality due to premedication with caustics.

The author concludes with a plea for the abandonment of the term "burn" in favor of "radiation reaction."

PERCY J. DELANO, M.D.

EXPERIMENTAL STUDIES

Study of the Cardiac Movements Simultaneously Recorded by Roentgen-Cinematography and Electrocardiography. Nils Westermark. Acta radiol. **22:** 393–403, May 1941. (In English.)

The study here reported was carried out on a series of 55 sheep. Metallic indicators were inserted at different points in the wall of the left ventricle and their movements were recorded by roentgen cinematography simultaneously with electrocardiographic studies. The comparison between the paths of the indicators and the electrocardiograms synchronously taken and recorded by a sound film camera showed an accuracy of 1/18–1/24 second.

The anterior portion of the cardiac base exhibited a piston-like action during systole, remaining comparatively quiet during diastole. The downward piston-like motion was shown to last during the period of initial tension when the pressure in the left ventricle rises. About the same time as the cardiac base turned to begin its recurrent movement the pressure curve from the left ventricle showed a slight but definite fall, followed immediately by a rise. As this rise cannot be attributed to the movement of the base, which on the contrary should result in a lowering of pressure, it must be due to contraction of the rest of the ventricular wall and a decrease in the ventricle lumen. "It would seem therefore that systole begins with a rapid downward movement of, at any rate, the anterior portion of the ventricular base toward the apex. This movement thus causes a rapid rise in pressure in the ventricle. On the pressure having attained a certain height a recurrent movement takes place on the part of, at any rate, the anterior portion of the cardiac base and the rest of the ventricle contracts producing a fresh rise in pressure. The downward movement of the ventricular base would thus seem to correspond to the initial tension and the subsequent generalised contraction of the ventricular wall. . .to the period of expulsion."

Apart from an inclination to approach the cardiac base, no contractile movement could be definitely ascertained on the outer contours of the wall of the ventricle. These contours seemed to describe a pendulating and rotary motion due to the movements of the entire heart.